Vertical motion estimated from combined ARGO and altimetry observations

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Introduction: importance of vertical motion

Vertical motion associated with mesoscale and sub-mesoscale oceanic features is of fundamental importance for the exchanges of heat, fresh water and biogeochemical tracers between the surface and the ocean interior. Unfortunately, direct measurements of vertical motions are difficult to obtain for usual values (order 10’s m/day). Various indirect methodologies have thus been proposed to estimate vertical velocity from observed density and geostrophic velocity fields. The most used technique is based on the solution of the quasi-geostrophic (QG) Omega equation (Tintore et al. 1991; Buongiorno Nardelli et al. 2001; Pascual et al. 2004; Ruiz et al. 2009).

Objectives & Context

The objective of this study is to estimate and analyze vertical exchanges associated with mesoscale dynamics and of their interannual variability from an observational data set. This work is performed in the framework of MESCLA, a R&D proposal funded within MyOcean EU FP7 project. MESCLA aims at:

1. Applying QG diagnostics to MyOcean products (model and observation based).
2. Comparing its results with corresponding primitive equation solutions.
3. Testing alternative techniques to combine satellite and in situ observations.

Auxiliary Data

Net Primary Production (NPP) data (gross photosynthetic carbon fixation minus the carbon respired to support maintenance requirements) provided by Oregon State University based on the original description of the Vertically Generalized Production Model (VGPM) (Barberfield & Falkowski 1997). More details at:
http://www.science.oregonstate.edu/oceanproductivity/

Period: 1998 - 2002 (seaWiFS based)
2003 - 2010 (modis based)

Temporal resolution: monthly timescale (weekly also available at the server)

Spatial resolution: 1/8°

Input Data

ARGO3D reanalysis
- M6 fields of temperature, salinity and density derived from a data assimilating system that combines SST and surface forcing (e.g. satellite altimetry, Argo profiling Floats, XBT, CTD and moorings) data (Guinehut et al. 2001)

Preprocessing
- Vertical interpolation: 10-1000 m
- Horizontal interpolation: regular grid (“10”)
- Conversion of data files to be inputted into the ROMS code for the estimation of vertical velocity

Output Data

MESCLA vertical velocity re-analysis

Period: 1993-2009
Temporal resolution: monthly
Horizontal resolution: spatial resolution: 1/5° grid
Vertical levels: 10-100 m
Domain: Gulf Stream

Summary & Future work

- This study is a contribution towards improving our understanding of the net effect of mesoscale variability on water mass formation and transport at the global scale, as well as its impact on the biochemical tracer redistribution and consequent marine ecosystem response.

- Further steps:
  - To investigate the potential impact of QG velocities on primary production in specific regions and events.
  - To perform sensitivity analysis of boundary conditions in the QG integration (topographic constraint).

Figure 1: Two snapshots of kinetic energy, vertical velocity, and net primary production. The dynamical fields are shown at 100 m, which is considered the average average layer in the Gulf Stream area (Oschlies and Garçon, 1998). Units are cm3/s2, m/day and mg C m-2 day-1, respectively.

Figure 2: Top: Time series of mean kinetic energy, magnitude of vertical velocity and net primary production, averaged over the common period of study (1998-2009). Right panels: as left panels but for deseasonalized data. Units are indicated in Figure 1. Isolines are 0 and 1000 m.

Figure 3: Left: maps of mean kinetic energy, magnitude of vertical velocity and net primary production, averaged over the common period of study (1998-2009). Right: as left panels but for standard deviation. Units are indicated in Figure 1. Areas shallower than 1000 m (bottom boundary in the QG w computation) have been masked.

Figure 4: Left: meridional section of mean kinetic energy, vertical velocity magnitude and net primary production, averaged over the common period of study (1998-2009). Right: as left panels but for zonal section. The area averaged is shown in Figure 3.

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