Lagrangian analysis of 3D mesoscale dynamics from altimetry and modelling
Application to jellyfish tracking in the north western Mediterranean

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Context: The Jellywatch project (PI: Gaby Gorsky)

Main characteristics of Pelagia Noctiluca
Numerous all along the year, in the NW-MED (Morand et al., 1992)
At surface during the night | migration in depth during the day (Dial vertical motion: can reach 400 m, Gorsky personal communication)

Main issues
What are the impacts of mesoscale and coastal dynamics on the jellyfish trajectories/distribution ?
In which way coastal-altimetry could be a powerful tool ?

Strategy and motivation
Strategy : Using altimetry to simulate the advection of Jellyfish both at surface and depth
Motivation : altimetry provide almost synoptic currents that should allow a long-term monitoring of Jellyfish transport

Model and study area characteristics
Model: SYMPHONIE (POC-SIROCO, Toulouse)
- Gulf of Lion regional configuration (Hu et al., 2009**)
- Boussinesq model
- One way Nesting: 3km ~ 1km
- Period: 2001-2010
Area of study: The NorthWestern Mediterranean Sea
- Northern Current (NC): seasonal variability (Gostan, 1967**)
- NC intrusion over the GoL continental shelf (Gati et al., 2006**)
- Intense mesoscale variability: eddies, meanders (Millot, 1991**)

Reconstruction of the sub-surface geostrophic current

Current intensity at 20m (in m/s)

DH rebuilt at 250 m
Altimetric ADT (AVISO and HR)
EOF climatology (SYMPHONIE)

Statistics
Spatial repartition
- Much more particles over the GoL (~ 50%…)
- Significant differences / products (West GoL > 10%)

Influence of DVM
- Also significant

Influence of MDT
- More particles shored with MDT Dob than with Rio

Perspectives (on-going work)
- The landfall of Jellyfish needs to be validated with independent data (observations of life guard: number of bites per season etc …)
- The effect of the wind has to be considered
- Add complexity in the Jellyfish behavior by coupling coastal altimetric current with an ecological model (LAGOO, Qiu et al., 2008**)

Conclusions
- Lagrangian approach is a powerful tool to evaluate coastal altimetry
- Comparisons with drifters show: the importance of the MDT resolution in coastal zone / of the multi-mission
- Our approach to simulate jellyfish trajectories shows the strong influence of the NC dynamics (in agreement with Qiu et al., 2008**)

Methodology
Step 1: Build daily Dynamic Height from T,S of the model (2001-2010)
Step 2: Compute a database of daily vertical EOF from the model DH
Step 3: Create an EOF climatology from 10 years of simulation
Step 4: Reconstruct DH at depth by projecting altimetric ADT with the EOF climatology

Altimetric data used
2 kinds of (M)SLA : From regional AVISO and Higher Resolution (HR) product (Escudier et al., 2011**)

Jellyfish trajectories (first results)
40 days advection with DVM (250 m)

Particle advection vs drifter trajectories

When same MDT is used, AVISO and HR show close results
MDT Dob allows a better agreement with drifter 2
No product show an advection by the coastal eddy

Particle advection with 10 days delay

In that case, both AVISO and HR product with MDT Dobricic capture the coastal eddy (intercepted by 2 coastal tracks) With MDT Rio: eddy not reproduced (coastal mask……)

Altimetry vs drifters (*)
Meridional and zonal components

Comparisons ( HR Dob)
Drifter 1 and 2: Good agreement for both (U,V)
Drifter 3: Strong Disagreement (lag ……).
Statistics slightly better with AVISO than with HR-Dob

Jellywatch

Morand et al., 1992
Qiu et al., 2008**
Hu et al., 2009**

Particle advection with 10 days delay

Altimetric ADT
AVISO Dob
AVISO rio
HR rio
HR dob

Reconstruction of the sub-surface geostrophic current

1st mode dominant: 70 % ~ weights ~84 %
Representativity of the climatology 8% < error < 14 %

Limitation in coastal zone
- Sub-sampling of coastal dynamics
- Significant error
- NO subsurface information
Dial vertical motion of jellyfish !!!!
- Key SSH to sub-surface geostrophic currents

Use of statistics from a realistic regional model
Develop / use alti. products dedicated to coastal zone

Step 2
Step 3
Step 1
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Advection (RK4, D’Ovidio et al.2008**)
with geostrophic currents by considering Jellyfish as passive particles with DVM

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- Study the interannual variability of jellyfish distribution and better understand its potential relation with climatological indexes

(**): Please ask for the associated reference.