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

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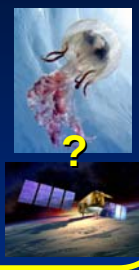
Context: The *Jellywatch* project (PI: Gaby Gorsky)



Main characteristics of *Pelagia Noctiluca*
Sparse informations on the Jellyfish repartition and the associated forcing (Temperature ? Current ? Wind ? Food ? Predator ? …)
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 personnal 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 powerfull tools ?

Strategy and motivation

Strategy : Using altimery 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

Limitation in coastal zone
- Sub-sampling of coastal dynamics
- Significant error

→ **Developt / use alti. products dedicated to coastal zone**

NO subsurface information
Dial vertical motion of jellyfish !!!!
Rely SSH to sub-surface geostrophic currents

→ **Use of statistics from a realistic regional model**

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

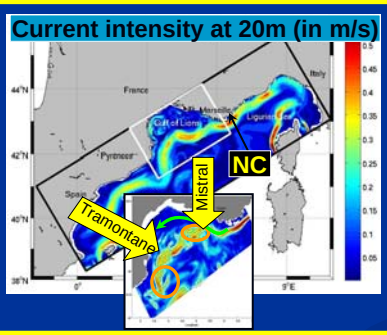
Advection (RK4, *D'Ovidio et al.2008***) with geostrophic currents by considering Jellyfish as passive particules with DVM

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): seasonnal variability (*Gostan*, 1967**)
- NC intrusion over the GoL continental shelf (*Gati et al*., 2006**)
- Intense mesoscale variability: eddies, meanders (*Millot*, 1991**)

Current intensity at 20m (in m/s)



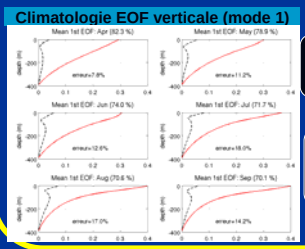
Altimetric data used

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

2 kinds of MDT: From *Rio et al*., (2007**) and *Dobricic et al*., (2005**)

Reconstruction of the sub-surface geostrophic current

Climatologie EOF verticale (mode 1)



1st mode dominant: 70 %< weigths <84 %

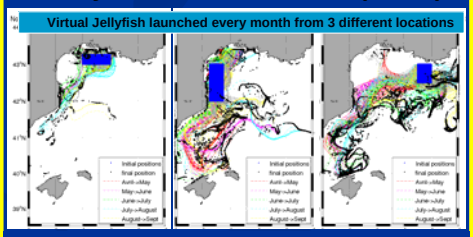
Representativity of the climatology 8% < error < 14 %

DH (250m) = DH (t,0m) EOF1(250m)/EOF1(0m)

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

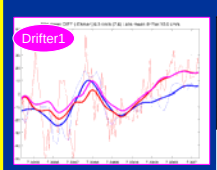
Jellyfish trajectories (first results)

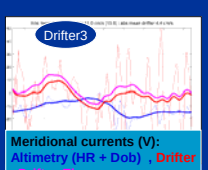
40 days advection with DVM (250 m)



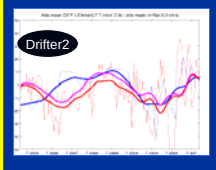
Altimetry vs drifters (*)

Meridional and zonal components





Meridional currents (V): Altimetry (HR + Dob) , Drifter , Drifter-Ekman



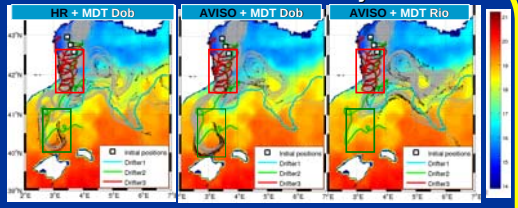
Altimetry: space/time interpolated at drifter locations

Drifters: current calculated by finite differences (5 days filtered)

Comparisons (HR Dob)

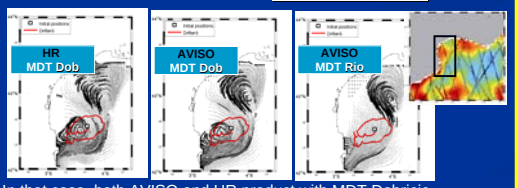
Drifter 1 and 2: Good agreement for both (U,V)
Drifter 3: Strong Disagreement (lag ….)
Statistics sligtly better with AVISO than with HR-Dob

Particle advection vs drifter trajectories



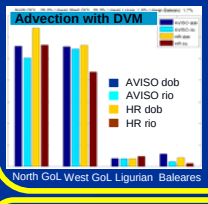
When same MDT is used, AVISO and HR show close results
MDT Dob allows a better agreement with drifter 2
No product show an advection by the coastal eddy

Particle advection with 10 days delay



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

Statistics



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

Influence of DVM
Also significant

Influence of MDT
More particules shored with MDT Dob than with Rio

Conclusions

- Lagrangian approach is a powerfull 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**)

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

(*) From the LATEX 2008 experiment: influence of submesoscale coupled physics – biogeochemistry on cross-shelf exchanges: http://www.com.univ-mrs.fr/LOB/LATEX

(**) Please ask for the associated references