



On the influence of coastal mesoscale dynamics on the jellyfish trajectories and distributions

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JELLYWATCH project

Modelling of jellyfish transport and stranding in the NW med

Main characteristics of *Pelagia Noctiluca*

- **Sparse information** on the Jellyfish repartition and the associated forcing (Temperature ? Currents ? Wind ? Food ? Predators ?)
- Numerous all along the year, in the NW-MED (*Morand et al, 1992*)
- At the surface during the day | migration at depth during the night (**Dial vertical motion (DVM)**: down to 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 ?



Outline

- Strategy and data used
- Reconstruction of sub-surface currents
- Validations / comparisons
- Jellyfish trajectories: preliminary results

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Strategy and data used

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



Limitation in coastal zone

- Sub-sampling of coastal dynamics
- Significant error



Develop / use alti. products dedicated to coastal zone*

** Dussurget et al, 2011 (see previous talk), Escudier et al 2011 (see poster) ...*



NO subsurface information

Dial vertical motion of jellyfish !!!!

Rely SSH to sub-surface geostrophic currents**



Use of statistics from a realistic regional model

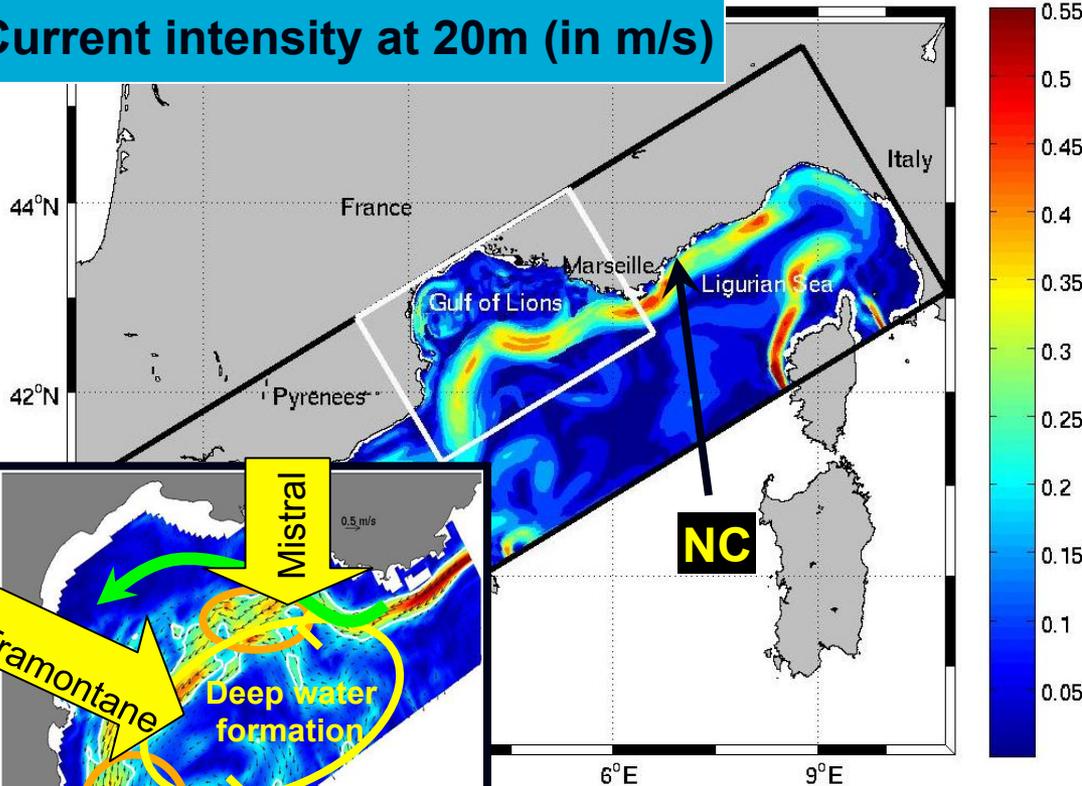
Pascual et al 2003 (Vertical EOF de mesure in situ + SSH altimétrique)

Strategy and data used

- The symphonie model (POC-SIROCO, Toulouse) and study area characteristics



Current intensity at 20m (in m/s)



Model: SYMPHONIE (GoL config., Hu et al., 2009)

- Boussinesq model
- One way Nesting: 3km -> 1km
- Period 2001-2010

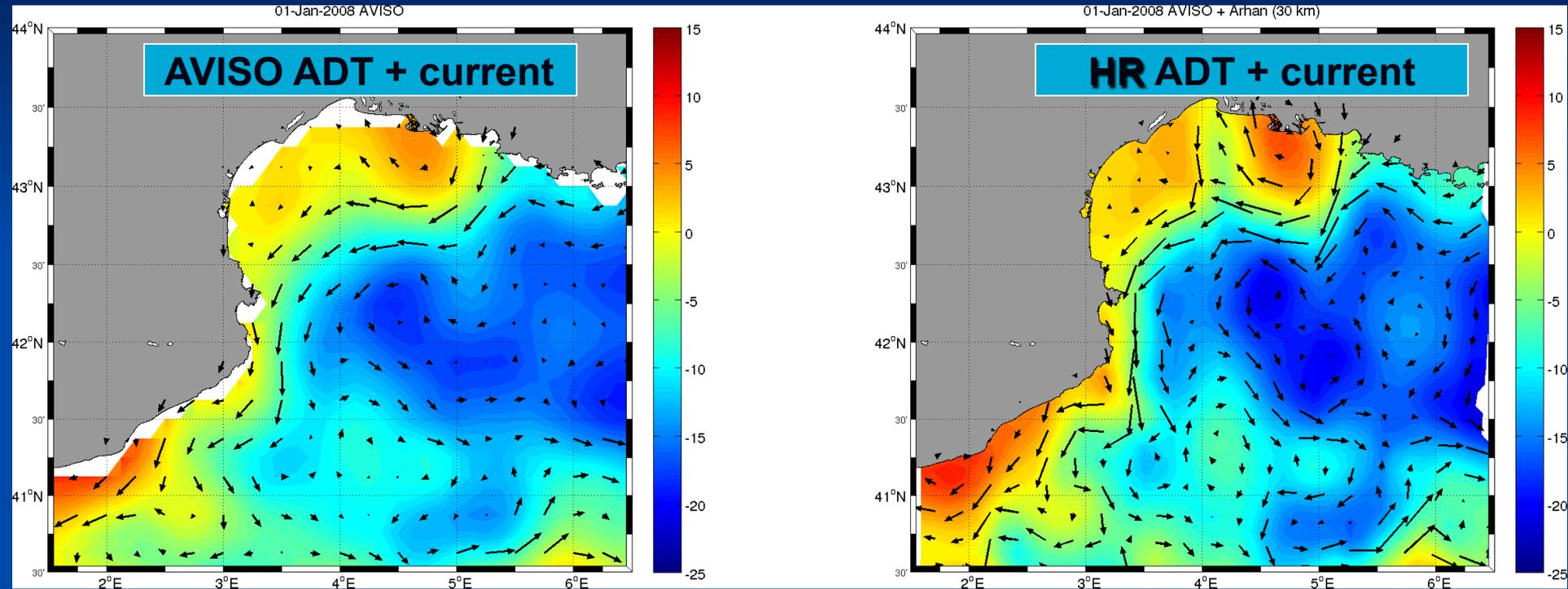
Study area :NWMed

- Northern Current (NC):
seasonal variability (Gostan, 1967)
- Intense mesoscale variability:
eddies, meanders (Millot, 1991)

- NC intrusion over the GoL continental shelf (Gati et al., 2006)
- Winter deep water formation characterized by a high interannual variability (Mertens and schott, 1998; Hermmann, 2008)

Strategy and data used

■ Altimetric products used



- 2 kinds of (M)SLA : From **regional AVISO** and **Higher Resolution (HR)** product (correlation scales: 5 days/30km) from IMEDEA (Escudier et al.,2011)
- 2 kinds of MDT: From Rio et al., (2007) and Dobricic et al., (2005)
- Validations with *in-situ* measurements from the LATEX08 experiment *

* influence of *submesoscale coupled physics – biogeochemistry on cross-shelf exchange*: <http://www.com.univ-mrs.fr/LOB/LATEX>

Strategy and data used

■ Methodology

Step 1

Build daily Dynamic Height (DH) from T,S of SYMPHONIE model (period 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

If 1st mode highly dominant, reconstruct DH at a given depth by projecting altimetric ADT with the EOF climatology of the model

Advection with geostrophic currents by considering Jellyfish as passive particules with dial vertical migations

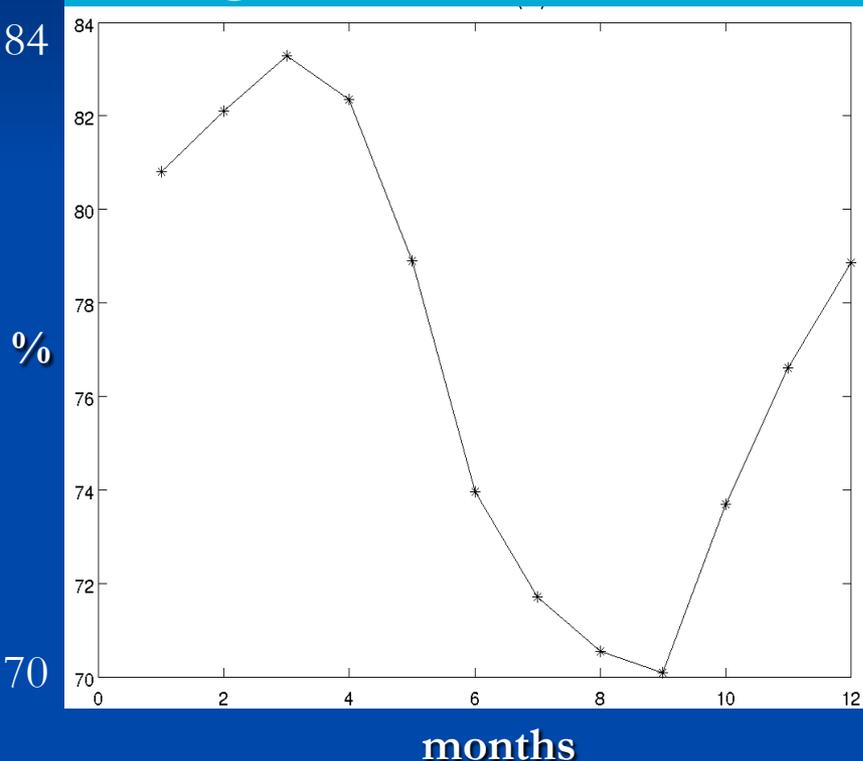
Is the 1st EOFmode highly dominant ?

Is the climatology representative of daily EOF ?

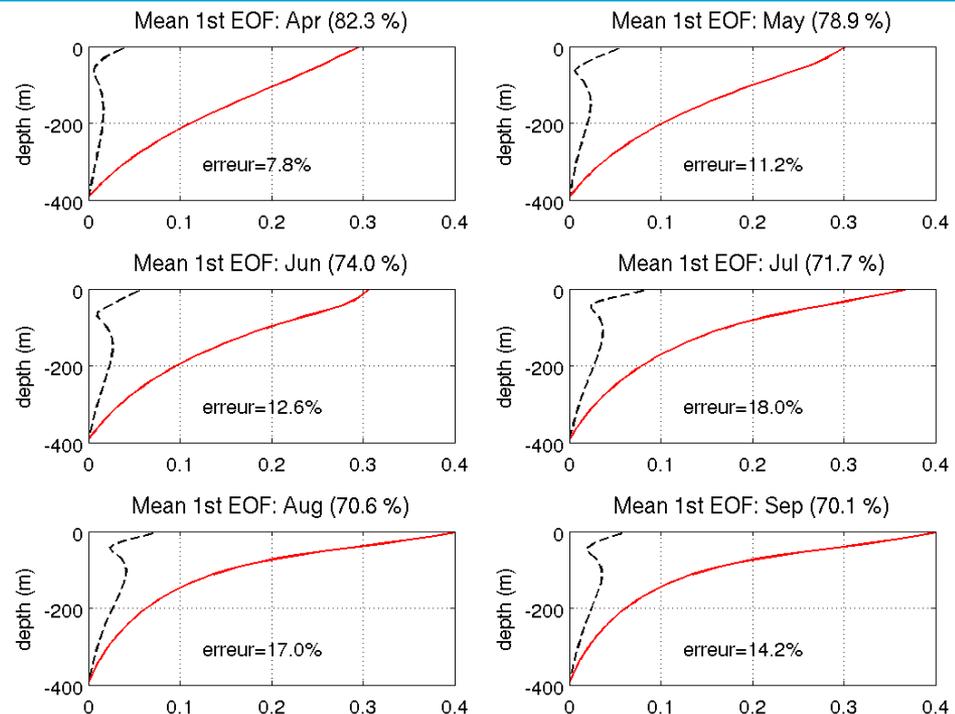
Reconstruction of sub-surface currents

- Create an EOF climatology from 10 years of simulation

Weights of mode 1 / month



Climatology vertical EOF (mode 1)



1st mode :
70 % < weights < 84 %

Representativity of the climatology
8% < error < 14 %

Reconstruction of sub-surface currents

- Create an climatology of EOF from 10 years of simulation:
 - If the first mode is highly dominant (as noted in *Pascual et al., 2003*) :

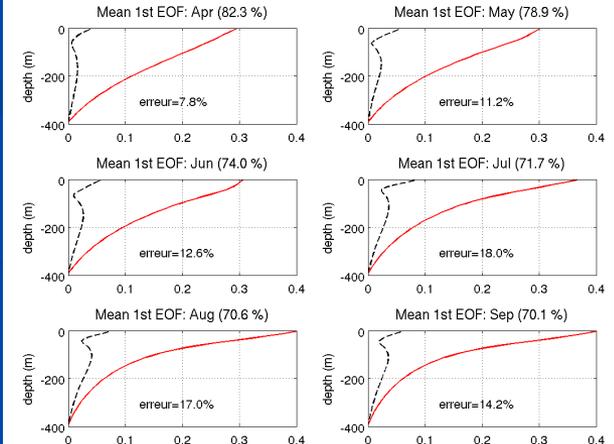
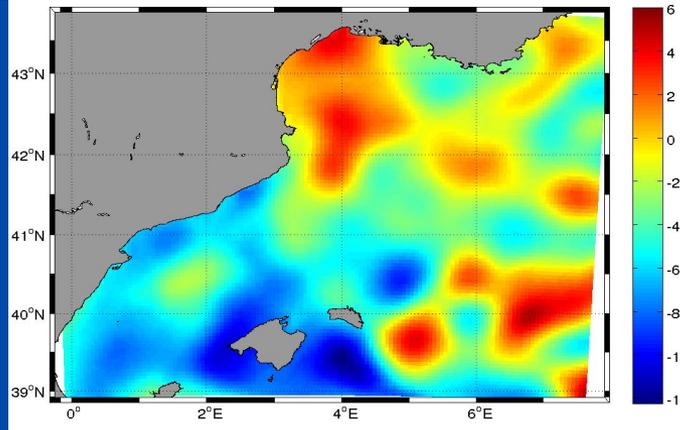
$$DH(t, 250m) = DH(t, 0m) \cdot EOF1(t, 250m) / EOF1(t, 0m)$$

DH rebuilt at
250 m

Altimetric ADT
(AVISO and HR products)

EOF Climatology
(from SYMPHONIE)

Geostrophic
current at 250m

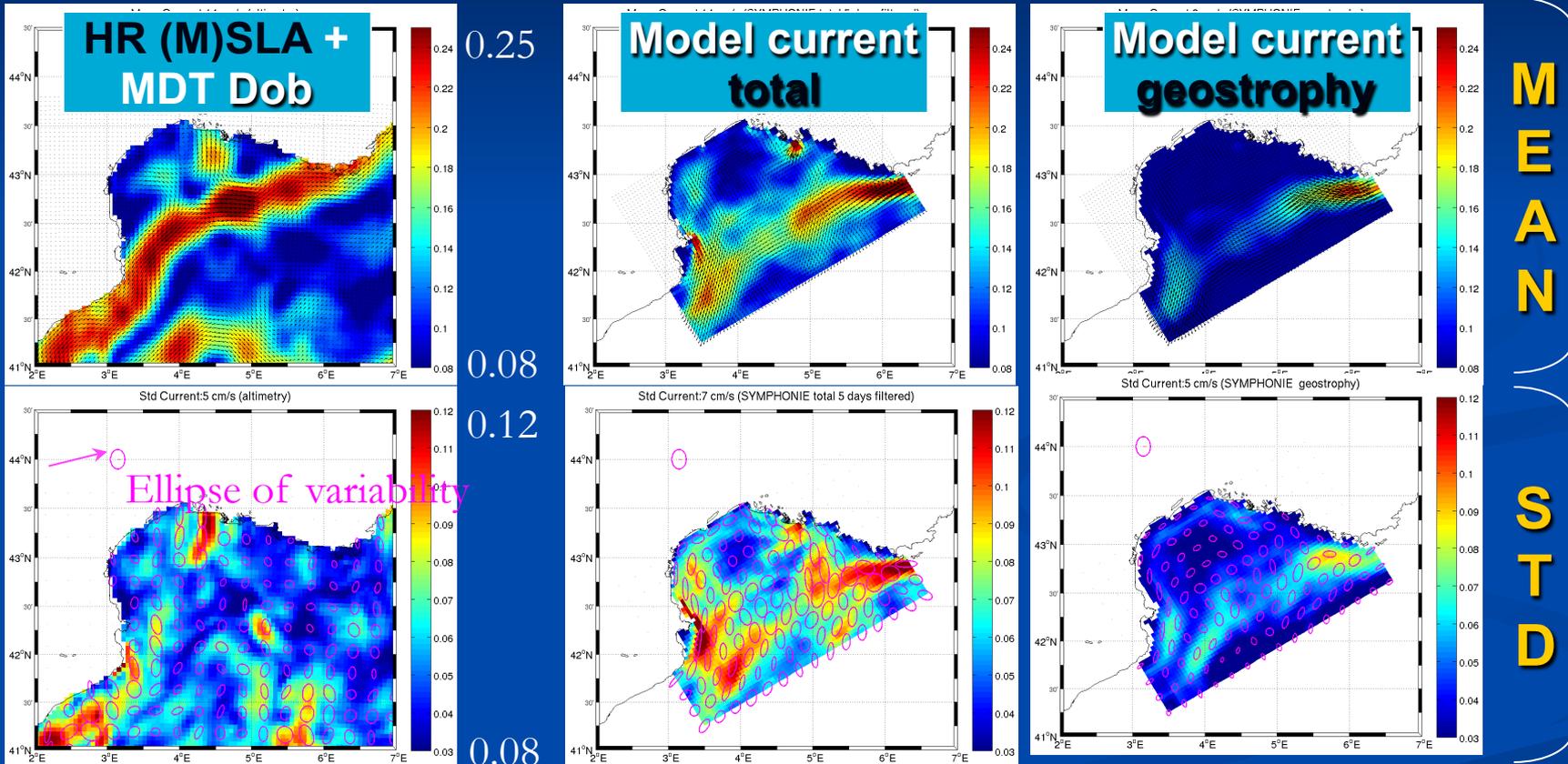


Are model and altimetric currents sufficiently consistent ?

Validations / comparisons

■ Altimetry vs SYMPHONIE model currents (April – october 2008)

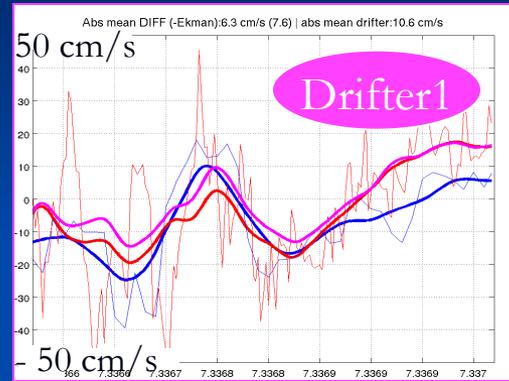
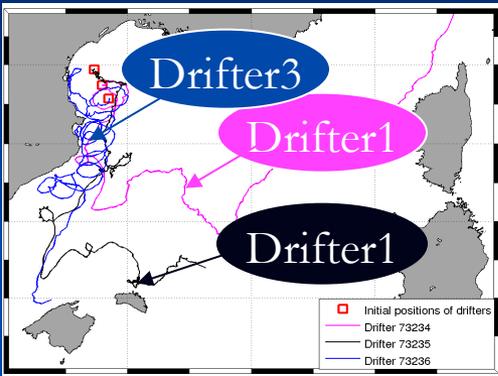
■ At the surface (m/s):



- Good agreement between model and altimetry (NC intensity/position ...)
- Model: Amplitude/Variability of total current \gg model geostrophic current (\rightarrow importance of ageostrophic and wind effects)

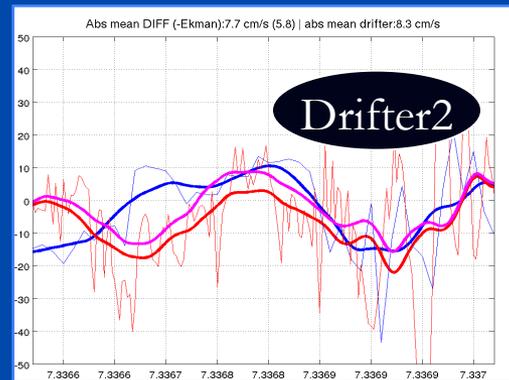
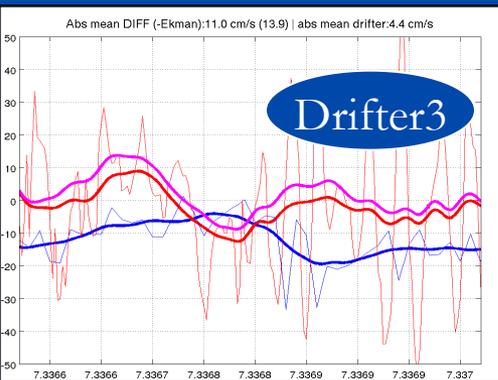
Validations / comparisons

■ Altimetry vs LATEX08 drifters comparisons (U & V components)



Method

- **Altimetry:** current space/time interpolation at 3 drifter locations
- **Drifters:** current calculated by finite differences (5 days filtered) + Ekman current removed



Comparisons (with HR Dob)

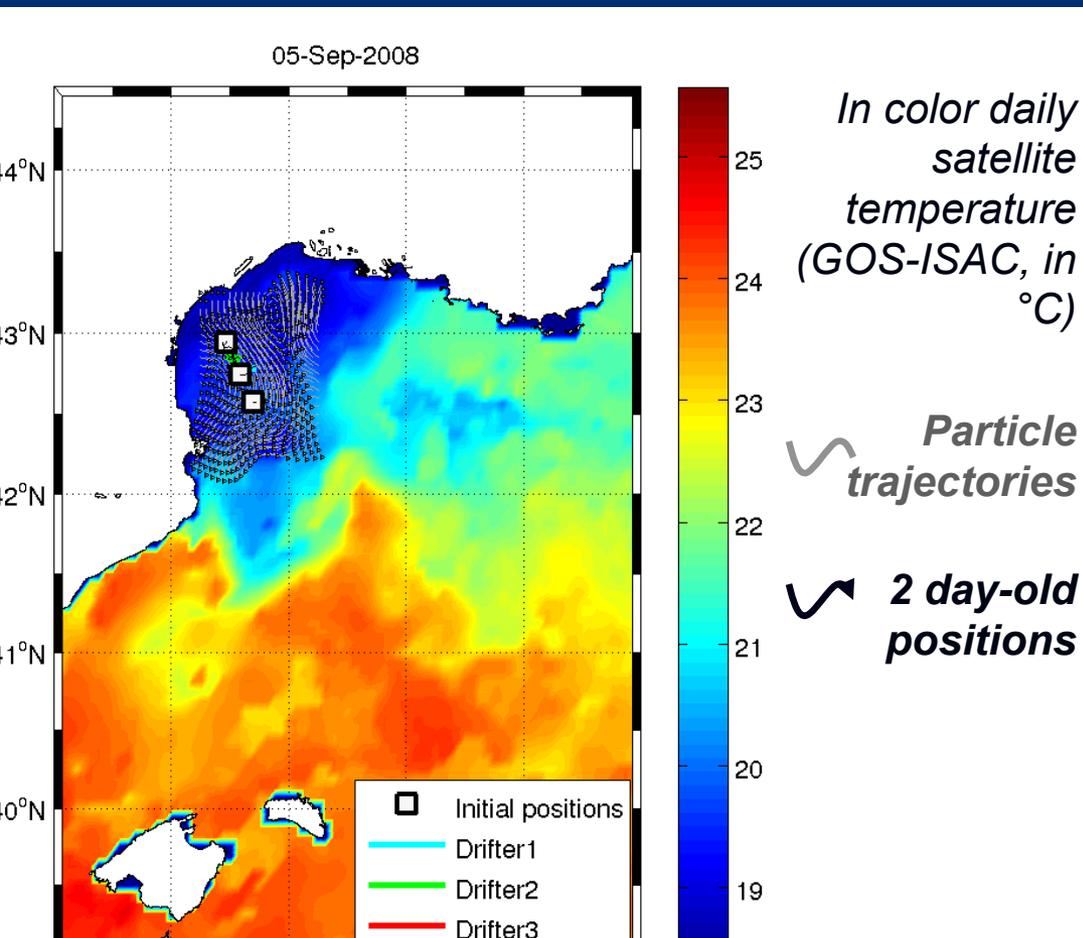
- **Drifter 1 and 2:** Good agreement for both (U,V) (absolute mean difference < mean absolute, correlations > 0.5)
- **Drifter 3:** Strong Disagreement (lag between the coastal structures)
- Statistics slightly better with AVISO than with the HR product

Comparison of meridional currents (V)
Altimetry (HR + Dob) , Drifter , Drifter-Ekman

What about the trajectories ?

Validations / comparisons

■ Altimetry vs LATEX08 drifters comparisons (lagrangian)



Method

- Virtual particles launched around the LATEX drifters initial positions.
- Particles advected 47 days using RK4 scheme from *d'Ovidio et al., 2008* and surface altimetric currents_

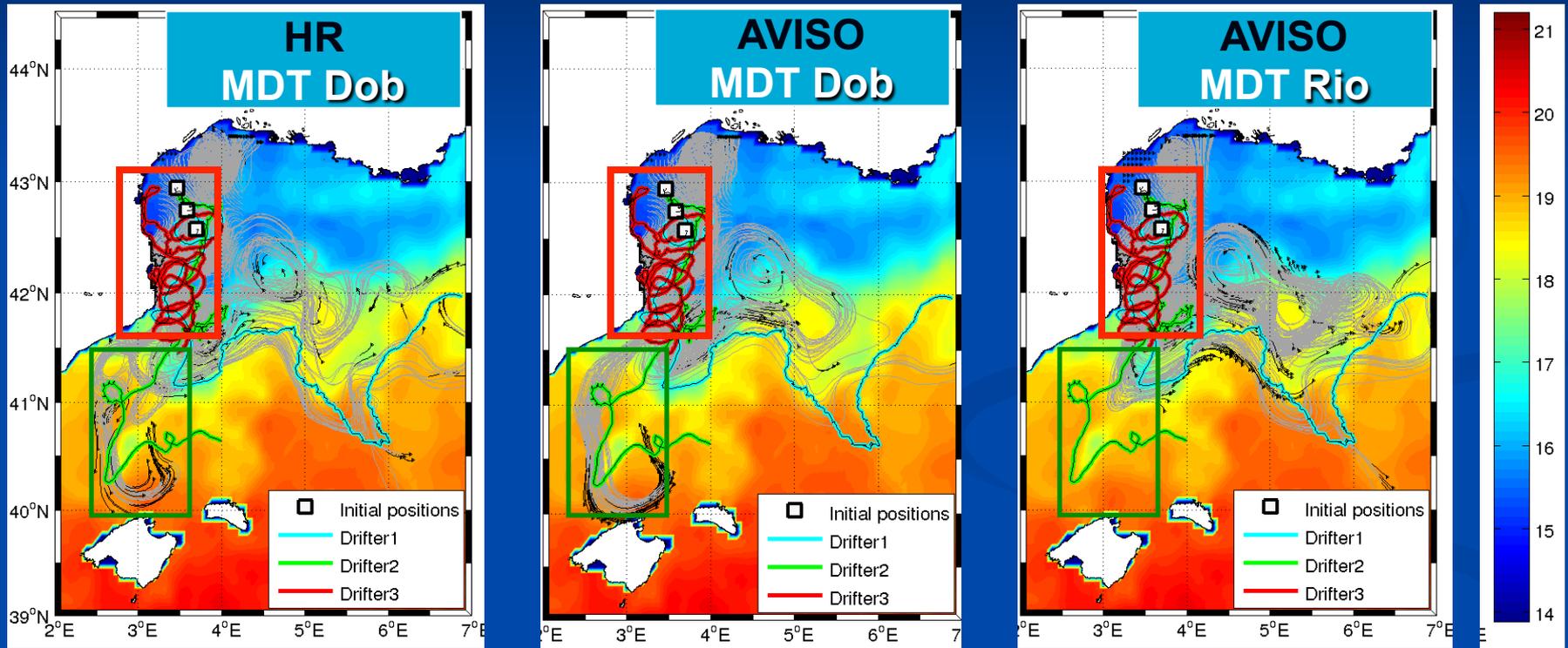
Results (with HR-Dobricic)

- The particles follow the main temperature fronts
- Very good agreement between the drifters 1 and 2 and the advected particles
- **No particle follows** the drifter 3 which is advected by a coastal eddy (cf. *Hu et al., 2009*)

Particles advection from altimetry (HR (M) SLA + MDT Dob) and drifters trajectories

Validations / comparisons

- Altimetry vs LATEX08 drifters comparisons (lagrangian)
 - Sensitivity to altimetric product used

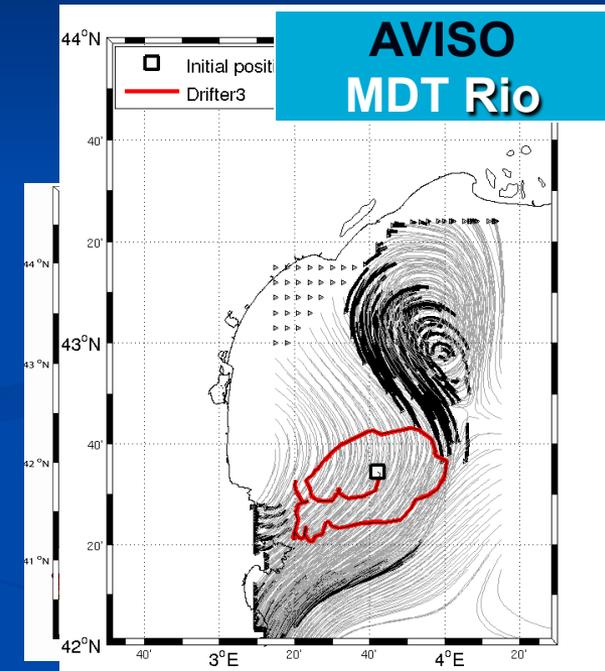
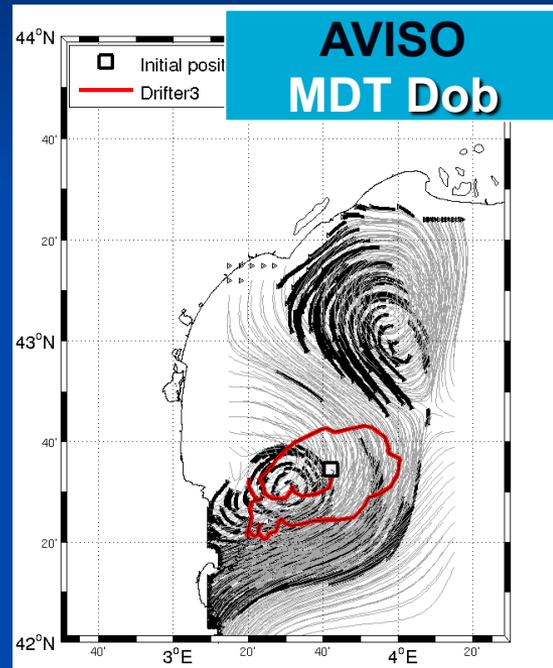
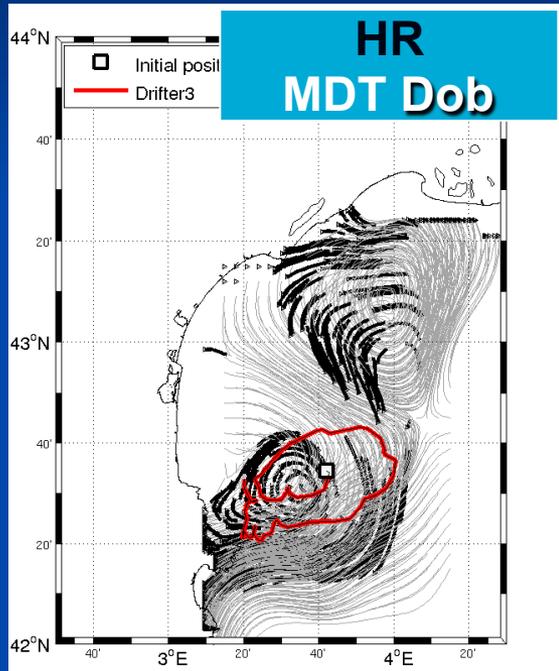


- When the same MDT is used, AVISO and HR (M)SLA show close results
- MDT Dobricic allows a better agreement with drifter 2 → **strong sensitivity to MDT**
- No product allows advection by the coastal eddy (observed with drifters 1 & 2) →

Why ?

Validations / comparisons

- Altimetry vs LATEX08 drifters comparisons (lagrangian)
 - Particles advection with a 10 day delay



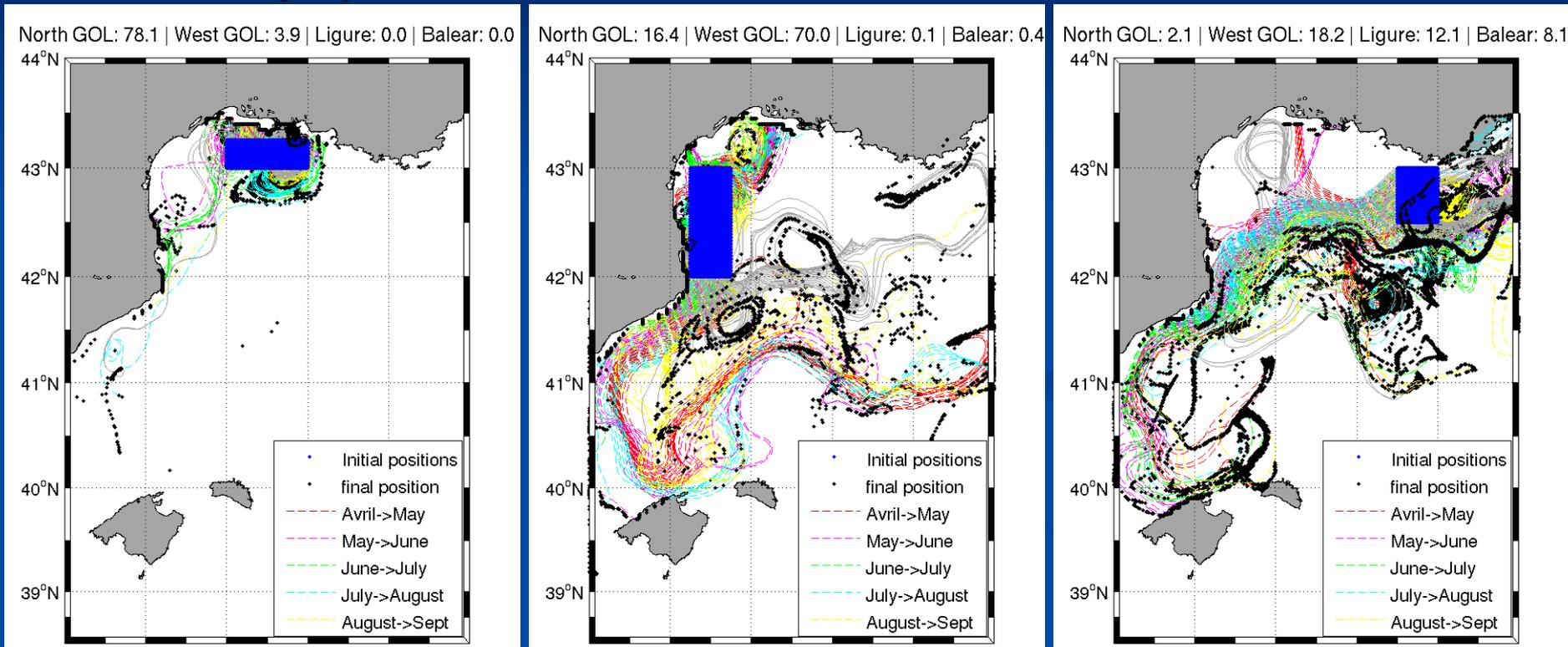
- Both AVISO and HR products with MDT Dobricic capture the coastal Eddy (2 coastal tracks intercept the structure) → Importance of track availability
- Eddy not reproduced with the MDT Rio: no grid point in the Northwest part of the GoL (coastal mask non well adapted)

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Jellyfish trajectories (preliminary results)

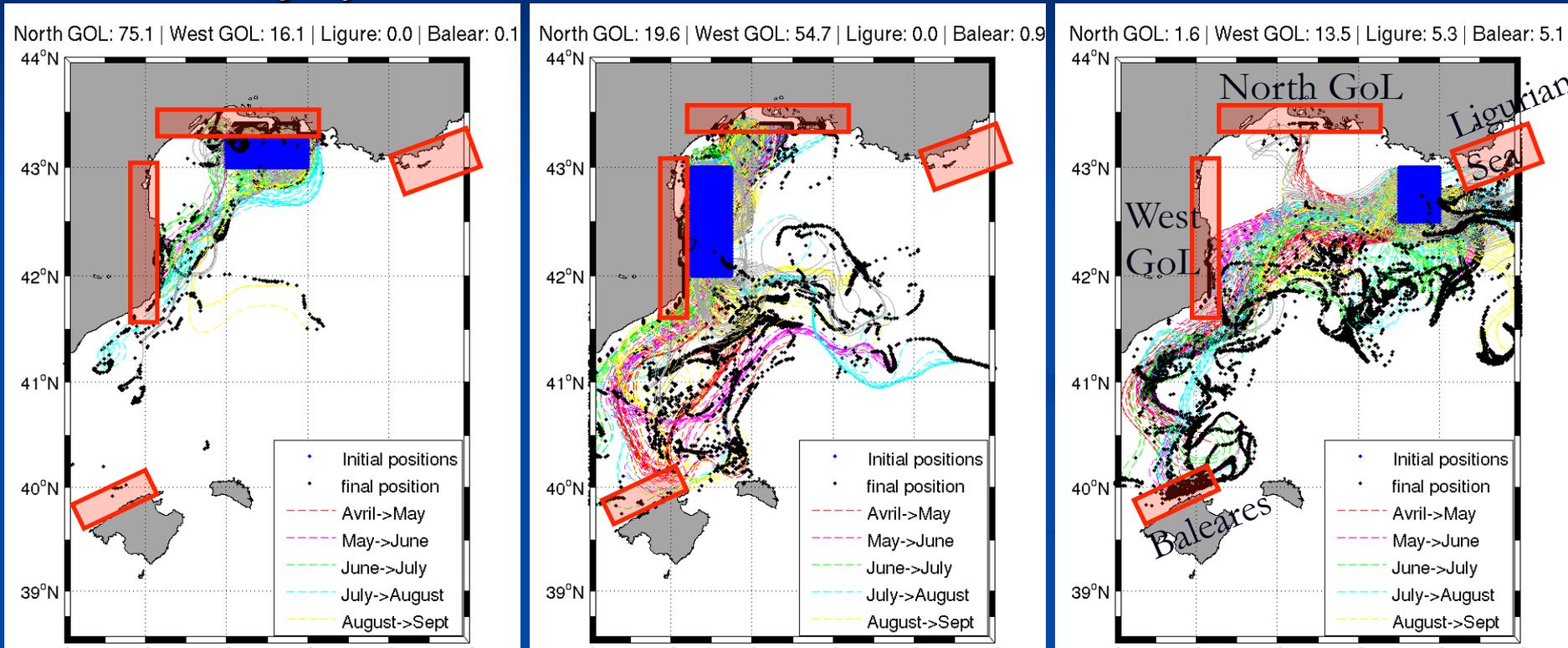
- Simple 40 day forward advection with altimetric surface currents
 - Virtual Jellyfish launched each month from 3 different locations



- **North GOL:** Most of the particles remain on the GOL
- **West/East GOL:** Advection southern by the NC in direction of the Balearic Sea.

Jellyfish trajectories (preliminary results)

- 40 day forward advection by taking into account the DVM
 - Virtual Jellyfish launched each month from 3 different locations



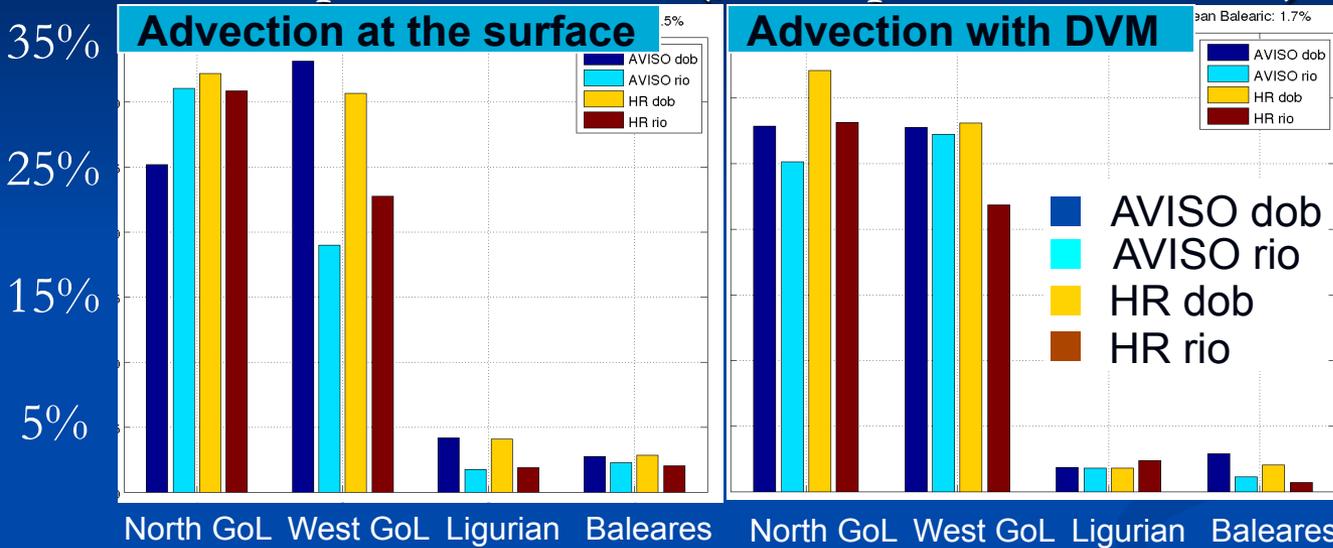
- **North GoL:** Much more particles advected to the south (3 times more)
- **West/East GoL:** Differences, but patterns also depending on the NC dynamics

Impact of DVM ? Impact of the altimetric product used ?

Jellyfish trajectories (preliminary results)

■ Statistics: differences due to DVM and altimetric products used

■ % of particles shored (/ total particles launched) over 4 areas



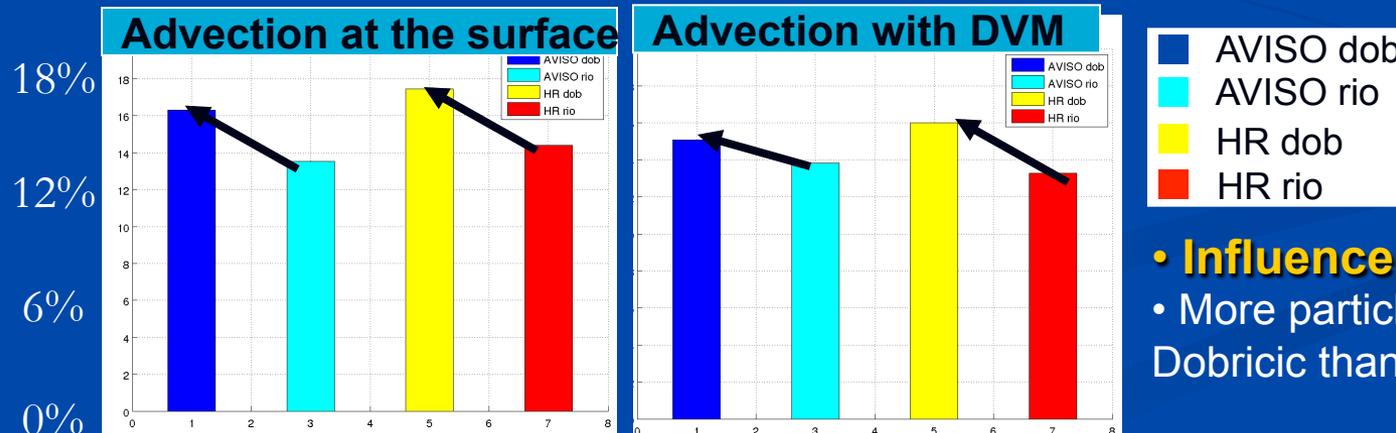
Spatial repartition

- Much more particles over the GoL (~ 50%...)
- Significant differences (e.g. West GoL > 10%)

Influence of the DVM

- Also significant (e.g. AVISO RIO)

■ % of particles shored: averaged over the 4 areas depending on the product



• Influence of the MDT

- More particles shored with MDT Dobritic than with Rio

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Conclusions and perspectives

■ Conclusions

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

■ Perspectives (on-going work)

- The landfall of Jellyfish needs to be validated with independent data (observations of life guard: number of bite per season etc...)
- The effect of the wind has to be considered
- Complexity in the Jellyfish behavior by coupling coastal altimetric current with an ecological model (LAGOO, Qiu et al., 2008)
- Study the interannual variability of jellyfish distribution and better understand its potential relation with climatological indexes

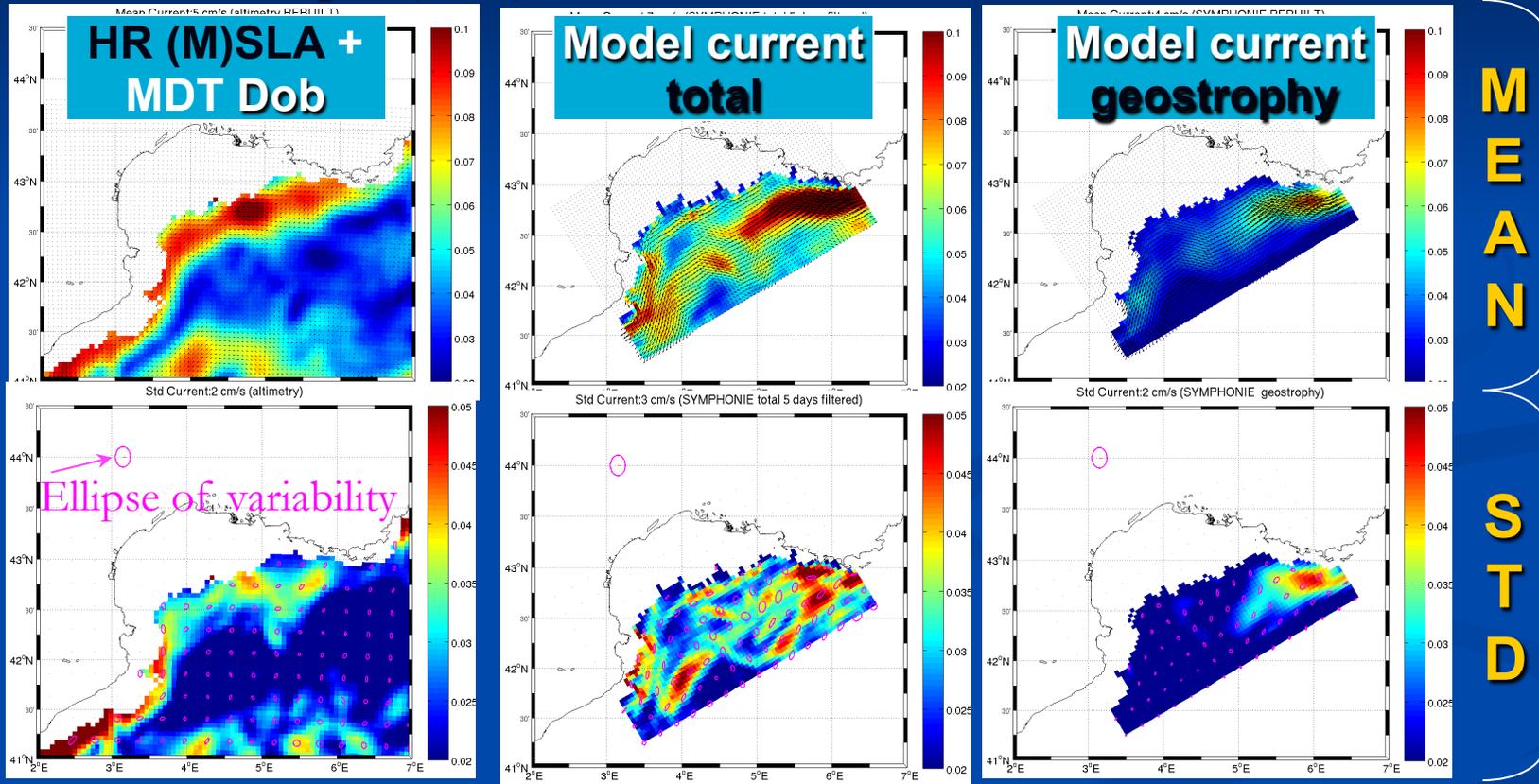


Thank you for your attention

Validations / comparisons

■ Altimetry vs SYMPHONIE model currents (April – October 2008)

■ At 150 m depth (m/s):



- Same conclusions at 150 m depth (but with 3 times less amplitude/variability)
- Other altimetric products (not shown !) show equivalent results (less variability in AVISO)