MESOSCALE CHARACTERIZATION USING ALTIMETRY AND GLIDER: METHODOLOGY AND ERROR BUDGET ASSESSMENT

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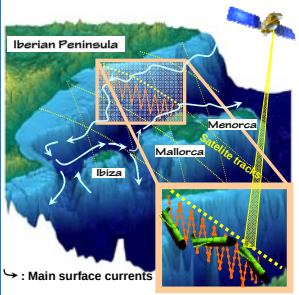
Objectives

To process, validate and intercalibrate multi-sensor datasets dedicated to coastal mesoscale studies:

- Implementation of the technological existent advances in satellite altimetry in the coastal area.
- Comparison between altimetry and glider data physical contents
- Resolution of the glider Reference level issue
- Evaluation of coastal-oriented altimetric corrections, retracking technics and editing strategies
- Coastal model validation at surface and along the water column
- 3D characterisation of mesoscale features in the coastal domain

General Glider Missions Background



ENVISAT:
T-773. (July 2007-June 2008) 7 glider missions (every 70 days).

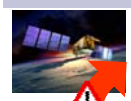
JASON-1/2:
T-70 (August 2008). Cycles Jason-2: 4 & 5.

JASON-1 (new orbit):
T-70 (May 2009 – June 2010), 5 glider missions.

Intensive observational program of 14 glider missions along altimetric tracks (July 2007- June 2010)

6500 full CTD casts
+ oxigen, chlorophyll, turbidity

Datasets



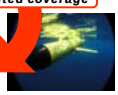
ALTIMETRY (ENVISAT, J1, J2)
- **Variable:**
  * (M)SLA and along track SLA (1Hz / 20Hz)
- **Horizontal resolution**
  * (M)SLA: 1/8°, 1Hz ~ 7km, 20Hz ~ 350m

Limitation in coastal zone Surface information

Complementary tools

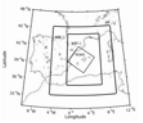
Ref. Level issue Limited coverage

COASTAL GLIDERS
- **Variables:**
  * P, T, S, oxig., chl., turb., GPS positionning
- **Horizontal resolution:**
  * GPS: 6km, others: 300 m / 1.1 km

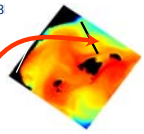


ROMS and WRF Models

Atmospheric model: WRF
- two nested grids : ***30km and 6km***,
- 47 vertical sigma levels.
- Boundary conditions: NCEP
- SST forcing: daily from CNR (5km)
- Period: 2007-2008



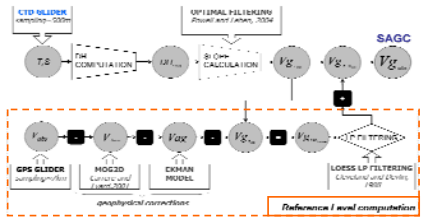
Oceanic model: ROMS
-32 sigma levels, spatial resolution : ~1.8
-Boundaries conditions : MFS
-WRF 6km, each 3 hours
-bulk formulation.



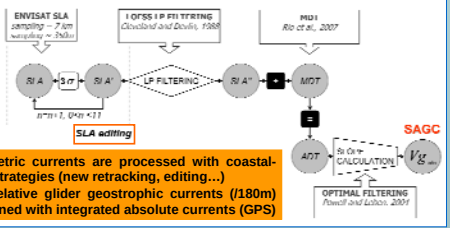
Variables (T,S, current) are space and time interpolated at the glider location

Data Processing

Glider Geostrophic Absolute Current computation



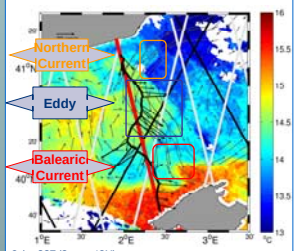
Altimetric Geostrophic Absolute Current computation



The altimetric currents are processed with coastal-oriented strategies (new retracking, editing…) Surface relative glider geostrophic currents (/180m) are combined with integrated absolute currents (GPS)

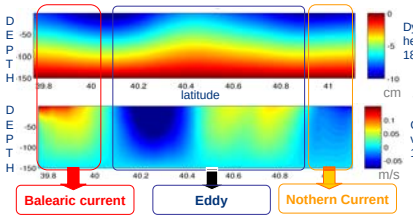
April 2008 Mission (ENVISAT)

Sinoptic view from satellite data



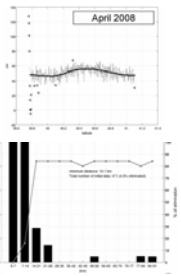
Color: SST (Source: ICM)
Grey arrows: Absolute geostrophic current (AVISO)
Black arrows: depth-averaged absolute current (glider GPS current)

Vertical structure from glider



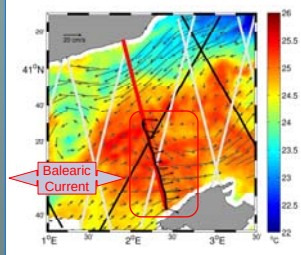
- The 3 dynamical patterns are observed in depth
- Marked horizontal gradients both in DH and the geostrophic velocity

20 Hz data selection

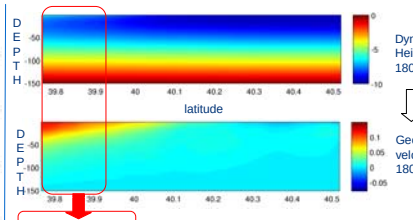


July 2007 Mission (ENVISAT)

Sinoptic view from satellite data

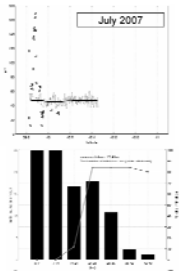


Vertical structure from glider

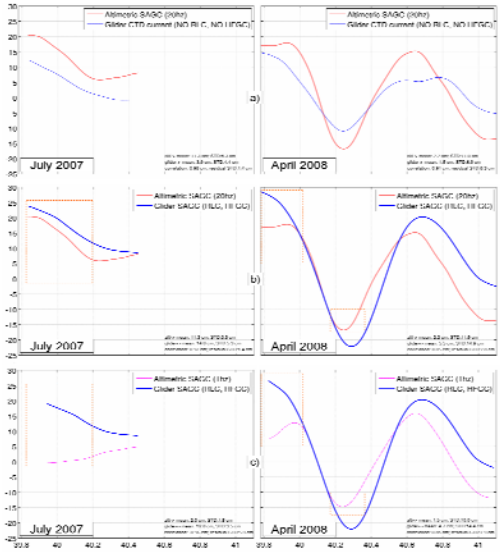


- Strong coastal currents at surface (between N39.8 and N40.1)
- Not deep (velocity /180m ~ 0 for depth>50m)

20 Hz data selection



Glider vs altimetric currents



SUMMARY (More details in Bouffard et al. JGR, october 2010)
- **The altimetric processing allows to obtain good agreements with the glider currents (corr. > 0.8 and % rms exp. > 50) for scales between 13 km and 25km.**
- **Using 20Hz (+ new editing) allows in some cases to keep a physical signals eliminated by a too much restrictive editing applied on 1Hz data (cf. above, Fig.b vs Fig.c).**
- **The glider Refrence Level Correction (RLC) increases the glider-altimetry consistency (cf. above, Fig.a vs Fig.b).**

August 2007 Mission (JASON 1 and JASON 2)

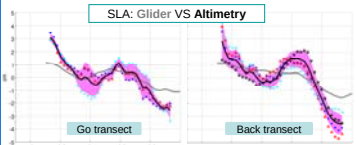
Impact of retracking

Products/ satellite	retracking	Resolution / filtering	Correc-tions
20Hz JASON-1	MLE4	~ 7 -18 km	1a
20Hz JASON-2	MLE4	~ 0,350 - 18 km	1a,1b,1c, 2c, 3c, 4c,5c
	RED3		
	OCE3		
	SVD		

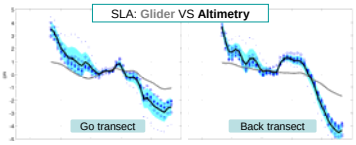
Impact of corrections

	1	2	3	4	5
Iono	GIM	BIFR_CMA	GIM	GIM	GIM
Wet trop	Rad(a) Composite(b) Decont.(c)	(a)(b).(c)	(a)(b).(c)	(a)(b)(c)	(a)(b)(c)
DAC	Yes	Yes	Yes	Yes	No
MSS	CLS01	CLS01	DNSC	CLS01	CLS01
PM	No	No	No	Yes	No

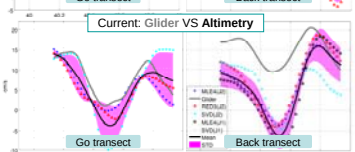
SLA: Glider VS Altimetry



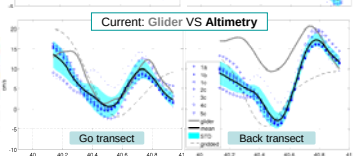
SLA: Glider VS Altimetry



Current: Glider VS Altimetry



Current: Glider VS Altimetry

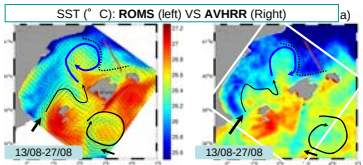


- **Much more gradient in altimetric than in glider SLA (RL issue in glider Dynamic Height).**
- **Very good agreement (corr>0.9) between glider and altimetric currents but bias (prob in GPS ?).**

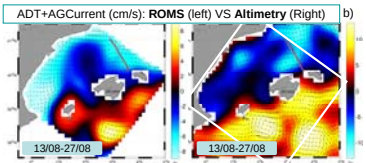
- **Significant differences are however observed, depending on retracking and corrections used:**
- **Sensitivity to retracking (SLA-current): 0.6 cm - 3.2 cm/s**
- **Sensitivity to corrections : 0.5 cm - 2.0 cm/s**

Glider vs Model vs Remote-sensing

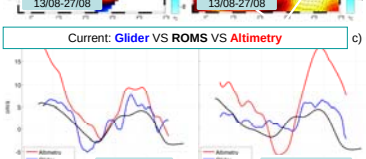
SST (°C): **ROMS** (left) VS **AVHRR** (Right) a)



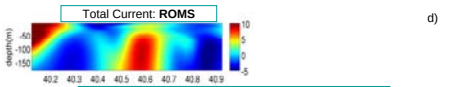
ADT+AGCurrent (cm/s): **ROMS** (left) VS **Altimetry** (Right) b)



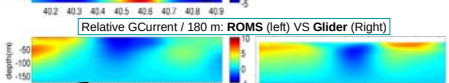
Current: **Glider** VS **ROMS** VS **Altimetry** c)



Total Current: **ROMS** d)

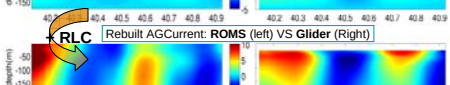


Relative GCurrent / 180 m: **ROMS** (left) VS **Glider** (Right)



RLC

Rebuilt AGCurrent: **ROMS** (left) VS **Glider** (Right)



FIGURES TO THE LEFT (a,b,c):
- **Physical features observed both at surface and depth are very well reproduce by the ROMS model.**
- **The model can thus be used to 1) evaluate the develloped methodologies and 2) better understand the mecanisms.**

FIGURES ABOVE (d):
- **Relative geostrophic and modelled total current are quite different. When the RLC is added ("Rebuilt AGC") the results are improved (other validation of the glider SAGC processing).**

REFERENCE:
Bouffard, J., A. Pascual, S. Ruiz, Y. Faugère, and J. Tintoré (2010), Coastal and mesoscale dynamics characterization using altimetry and gliders: A case study in the Balearic Sea, *J. Geophys. Res.*, **115**, XXXXXX, doi:10.1029/2009JC006087.