Comparing altimetry-derived geostrophic current anomalies with other observations

M. Cancet[1], E. Jeansou[1], F. Birol[2], S. Labroue[3], M. Le Hénaff[4], R. Morrow[2], N. Picot[5], A. Guillot[5]

[1]NOVELTIS, [2]LEGOS/CTOH, [3]CLS, [4]RSMAS, [5]CNES

- GlobCurrent User Consultation Meeting -

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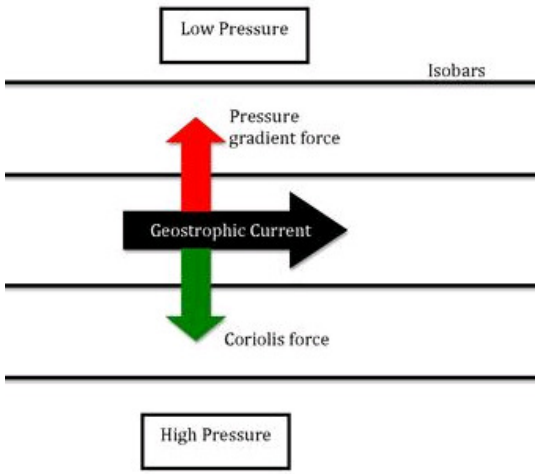
Plan

- What are ocean surface currents ?
- How to observe currents especially in altimetry ?
- How to validate the altimeter currents ?
- Case study: the Florida Strait
- Recommendations for the GlobCurrent project

Ocean surface currents

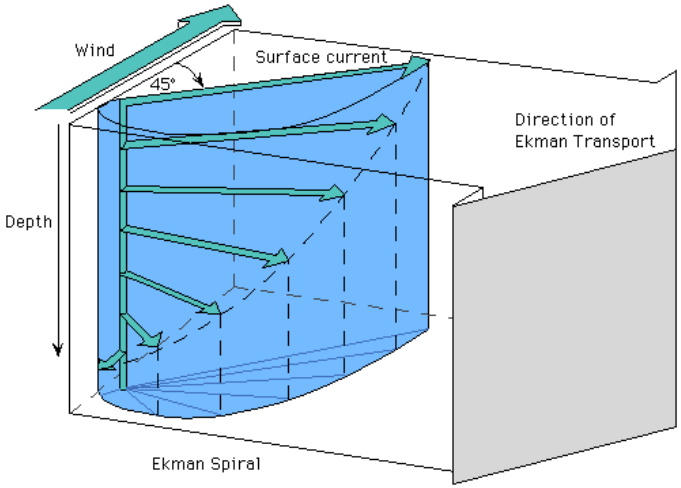
$V_{Geostrophic} + V_{Ekman} + V_{Tide}$

Balance Coriolis/pressure



Source: Wikipedia

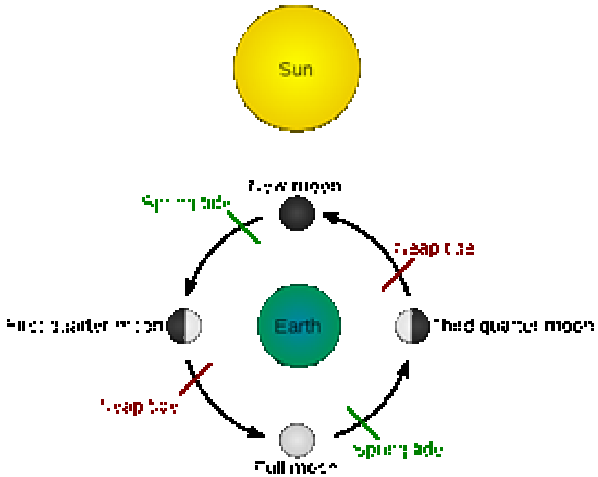
Surface wind forcing



Adapted from Thurman, Harold V. **Essentials of Oceanography, 5th ed.** Prentice-Hall, Inc., 1996.

Source:earth.usc.edu

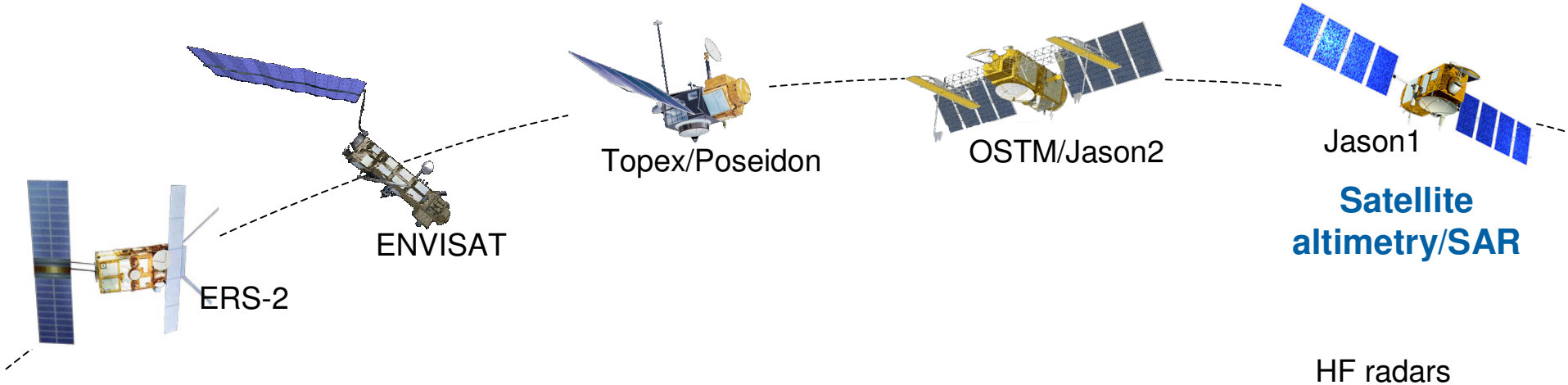
Rise and fall of the tide



Source: Wikipedia

- Direct observations: quantitative
  - In situ measurements
  - Satellite observations (SSH)
- Indirect observations: qualitative
  - Sea Surface Temperature / Salinity fronts
  - Ocean color mesoscale structures (filaments, eddies)
- Models outputs
  - Surface currents computation
  - Structures positions in various parameters (SSH, SST, SSS,…)

- Diversity of (quasi)-direct observations

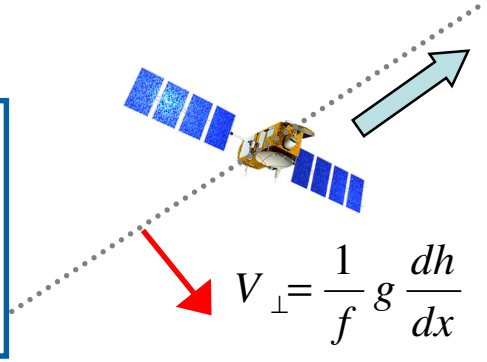


- Altimetry-derived geostrophic current anomalies
  - SLA global maps ➔ total current anomalies
  - Alongtrack SLA ➔ across-track current anomalies

Altimetry data global error:

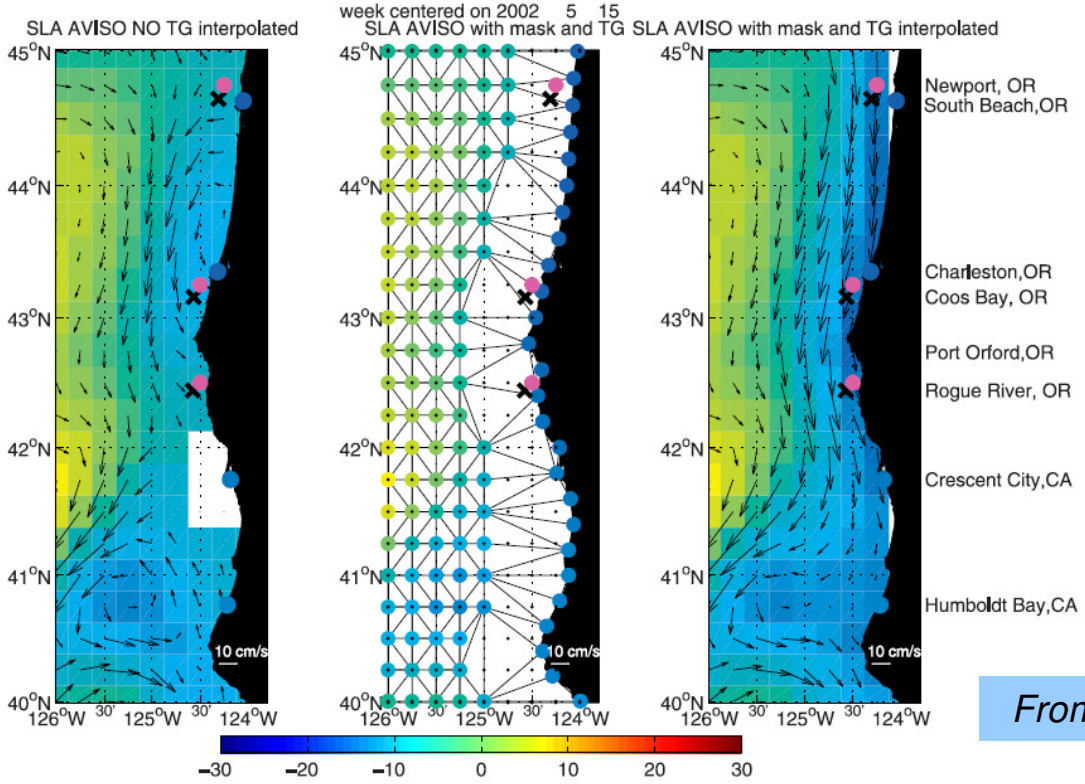
-SSH: ~3cm

-Currents: ~5cm/s (Powell & Leben,2004)



- Recent progress in coastal altimetry: Improving 2D maps

  - Merging with tide gauges data along the coast ➔ better coastal currents



From Saraceno et al., 2008

  - Using shorter correlation scales and high resolution altimeter data in the mapping processing ➔ mesoscale structures (Dussurget et al, 2011)

- Recent progress in coastal altimetry: Improving alongtrack data

  - Coastal or regional specific corrections
  - Dedicated retracking methods
  - Specific editing strategies
  - High frequency data processing
  - Several projects: PISTACH (CNES), COASTALT (ESA), X-TRACK (CTOH), …

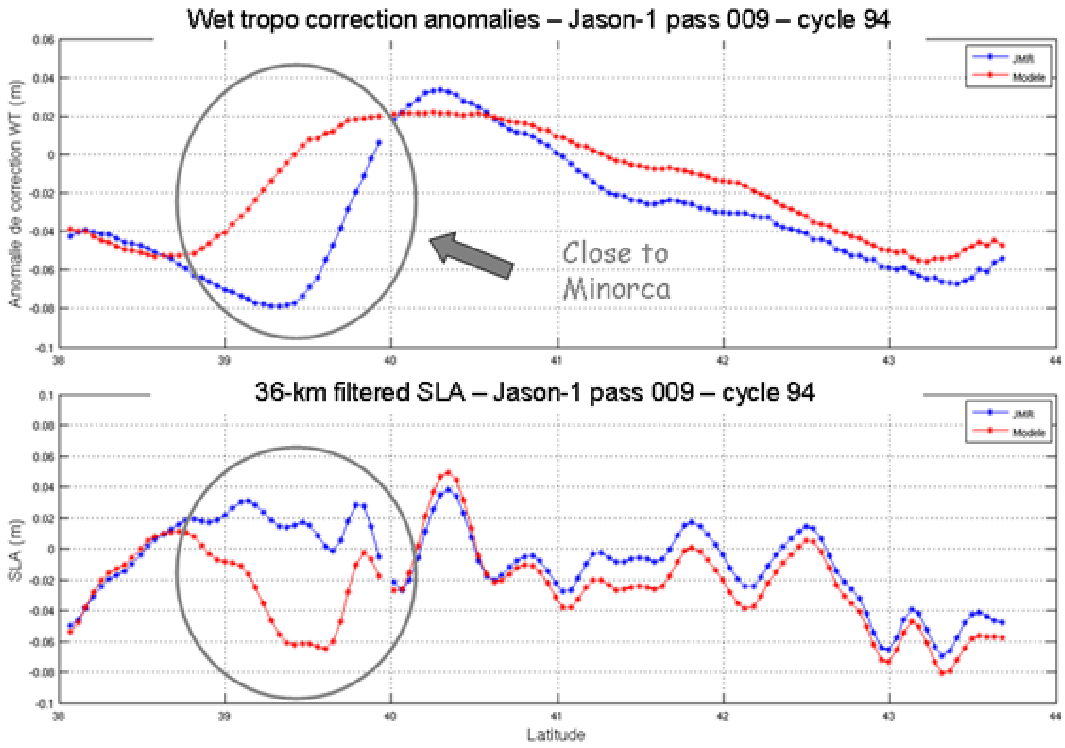
- Recent progress in coastal altimetry

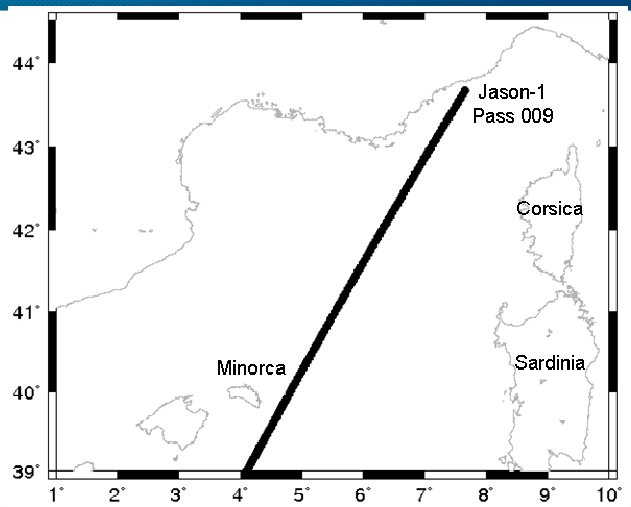
Questions:

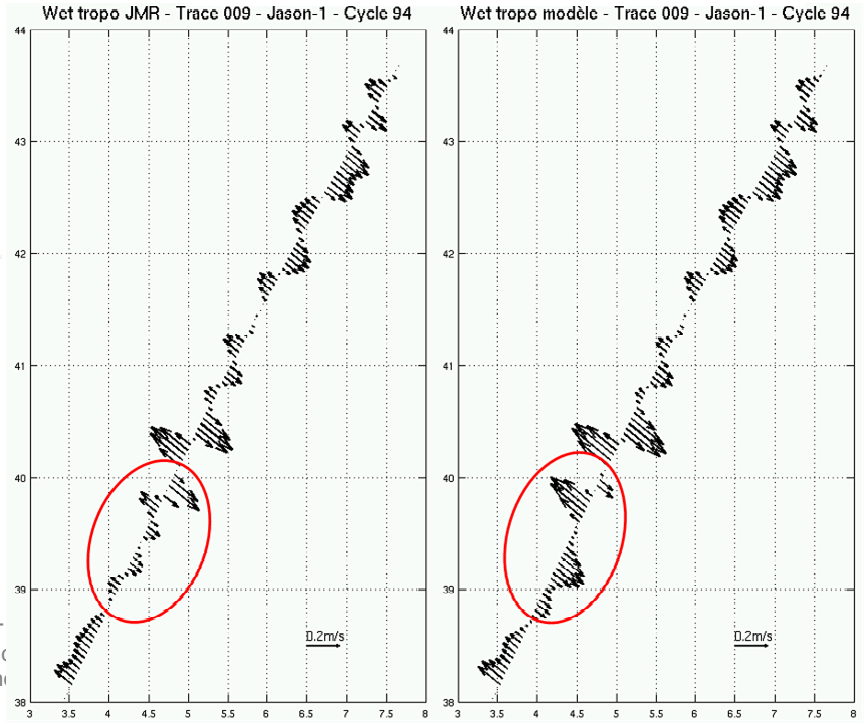
➔ Realism of the retrieved SSH (and consequently current) data near the coasts / of the improved 2D-maps (structures smoothing) ?

➔ Added-value of the coastal processing compared to classical SLA data ?

➔ Impact of the various coastal-oriented processing and corrections ?







Which one is the most realistic ?

- Recent progress in coastal altimetry

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➔ Realism of the retrieved SSH (and consequently current) data near the coasts / of the improved 2D-maps (structures smoothing) ?

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Qualitative and quantitative comparisons to independent data (SSH and currents)

- Direct observations physical contents differ

Type of Data	Type of Instrument	Geostrophic	Ekman	Tide/HF
In situ	Currentmeter/ADCP/CTD	X	X	X
	HF radars	X	X	X
	Gliders	X		X
Satellite (EO)	Altimetry	X		X
	SAR	X	X	X

Homogenization post-processing of the data is required before comparing.

- Direct observations availabilities differ

Type of Data	Instrument	Repetitivity	Spatial cover
In situ	**Currentmeter/ ADCP/CTD**	**Mooring:** Long records (few minutes sample) **Ship:** A few days, ponctual	**Mooring:** Very local (1 point) **Ship:** Local, a few km
	HF radars	Long records (1 hour)	Local, a few km
	Gliders	A few days, ponctual	Local, a few km
Satellite (EO)	**Altimetry**	10 days to 35 days	Global
	SAR	35 days	Global

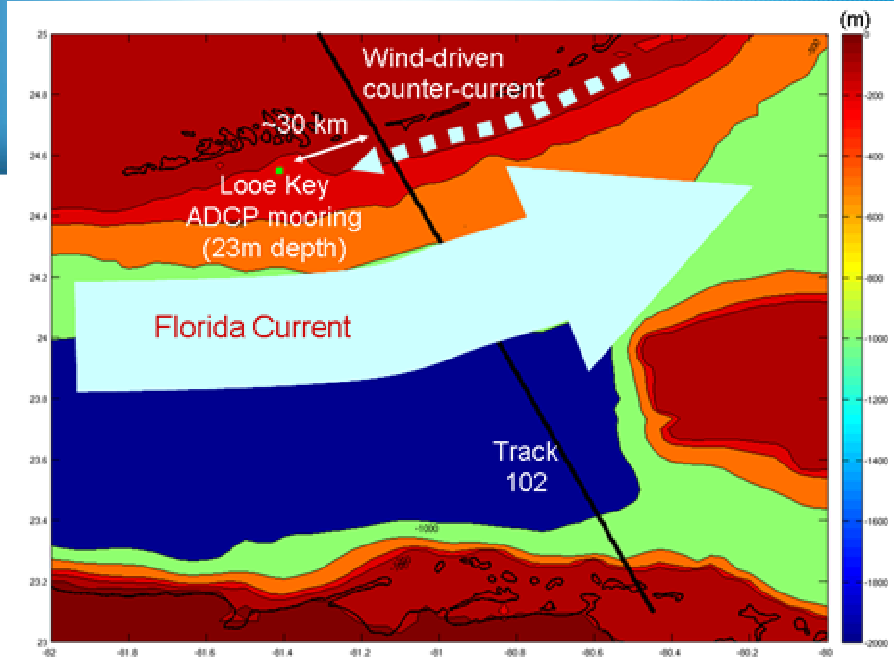
Along-track comparisons require :

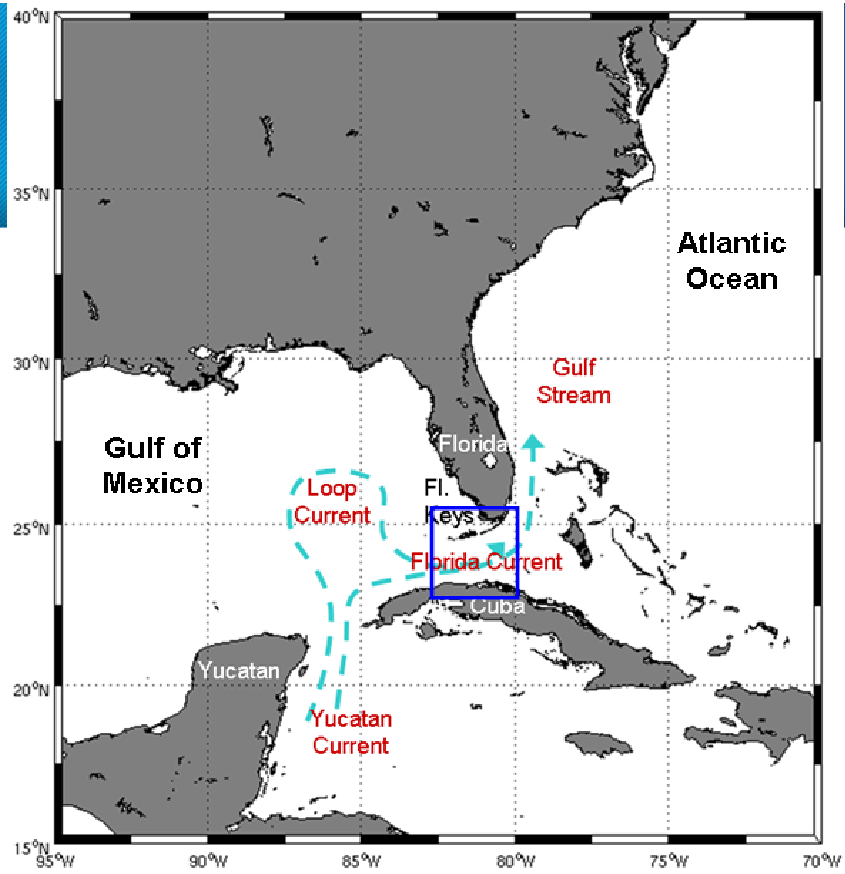
→ Long time series of independent data

→ Under (or near) the altimeter ground-track

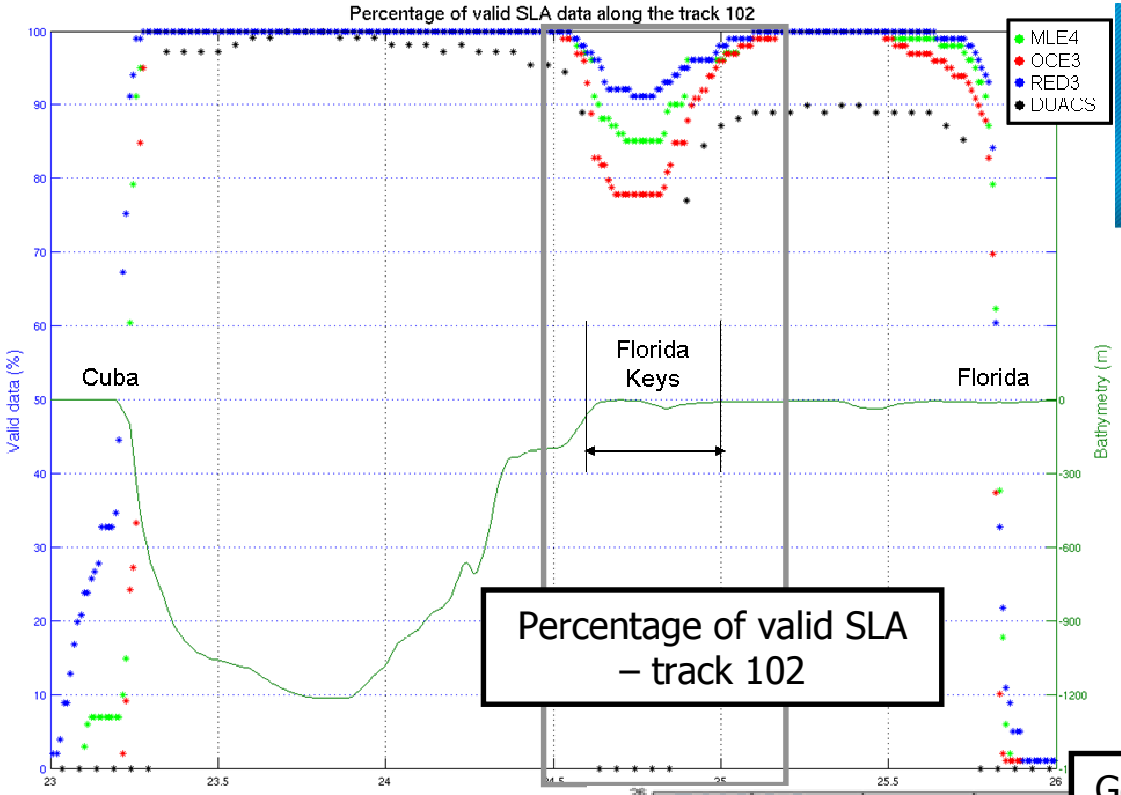
→ Areas with steady geostrophic structures

- Example: PISTACH level-3 products in the Florida Strait
  - PISTACH project:
    - Funded by the CNES
    - New processing methods and corrections dedicated to coastal applications
    - Up to now: Jason-2 IGDR products + about 80 extra fields
    - PISTACH level-3 products: high frequency SLA on reference ground-tracks
  - "Test zones" chosen after consulting the coastal altimetry community
    - The Florida Strait (2011)
    - The Agulhas Current (upcoming in 2012)



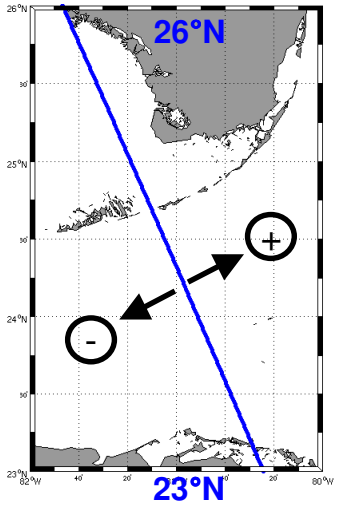


- 4 altimetry SLA datasets
  - PISTACH data: 5Hz products (1.4km), 7km low-pass filtered
    3 retrackings: MLE4, RED3, OCE3
  - Jason-2 DUACS SLA: monomission 1Hz product
- Post-processing:
  - See presentation: Cancet et al., 5th Coastal Altimetry Workshop, 2011
    http://www.coastalt.eu/sandiegoworkshop11/

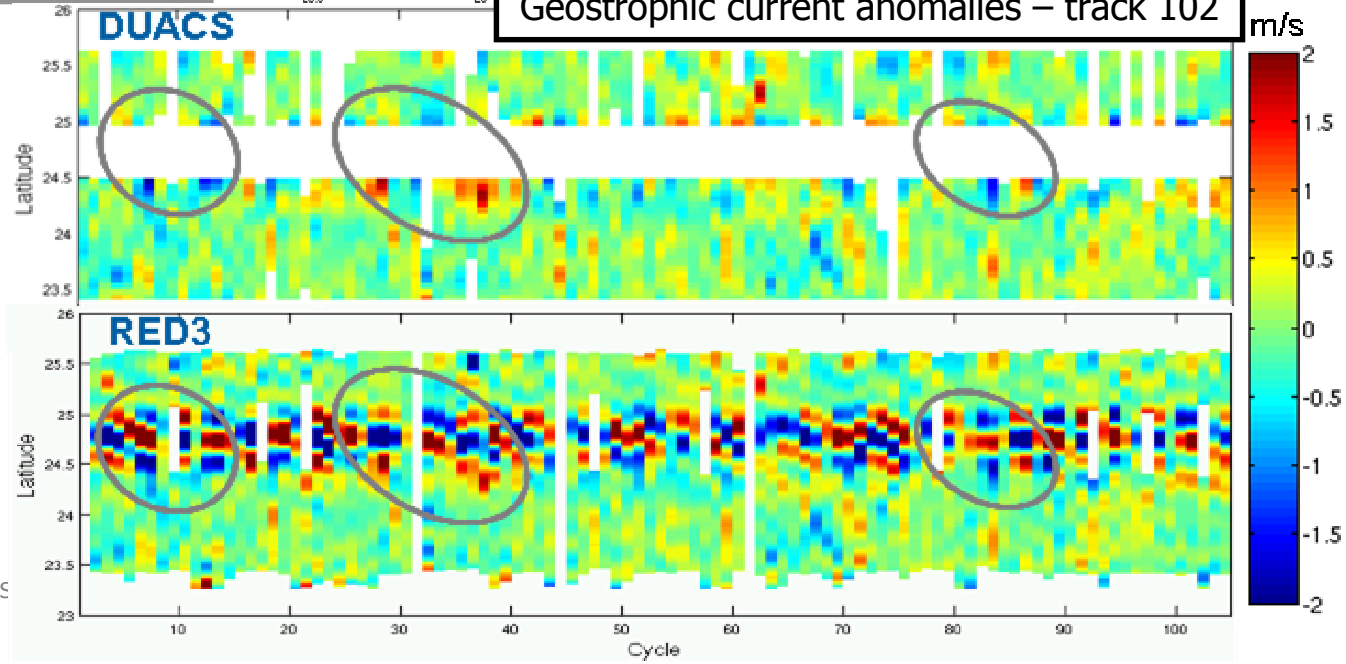


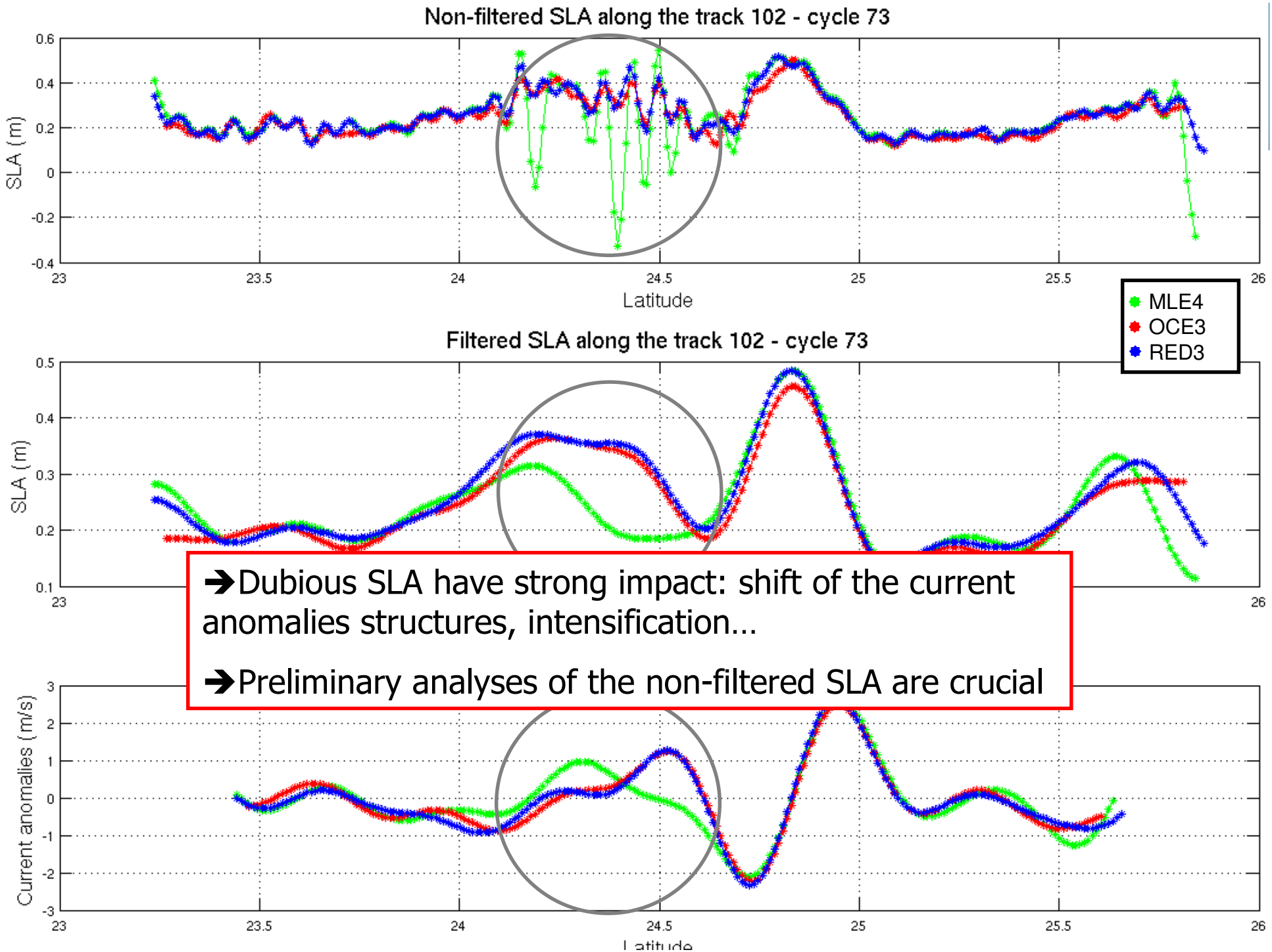
Percentage of valid SLA – track 102

- ✓ Large gain of SLA data with the PISTACH products
- ✓ Coherent signal near the Keys, consistent with the DUACS products



Geostrophic current anomalies – track 102

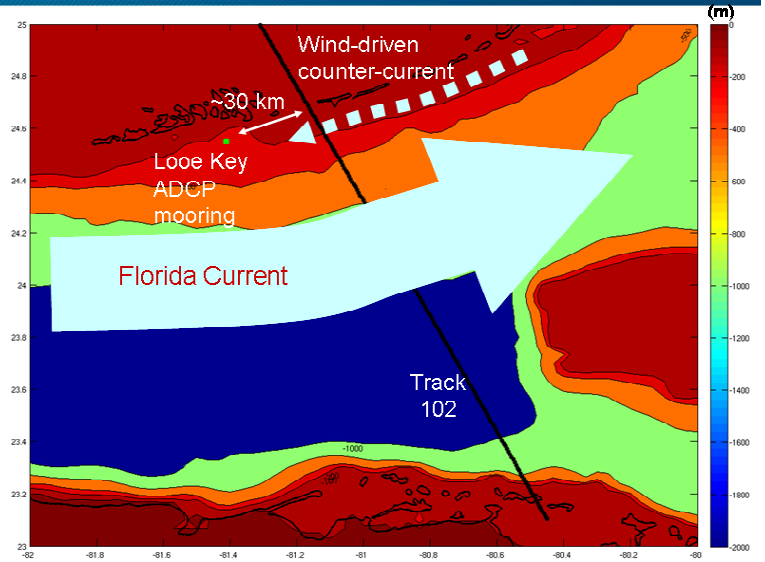


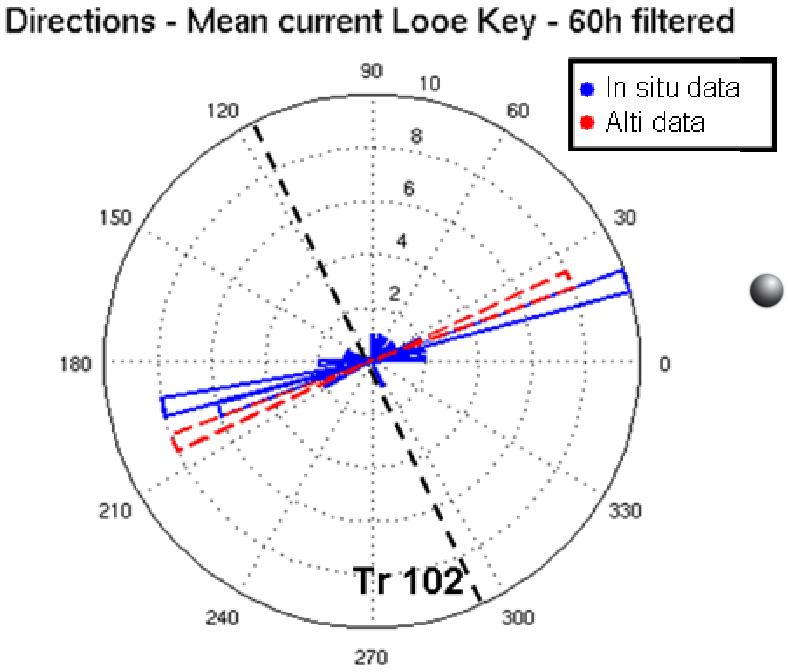


➔Dubious SLA have strong impact: shift of the current anomalies structures, intensification…

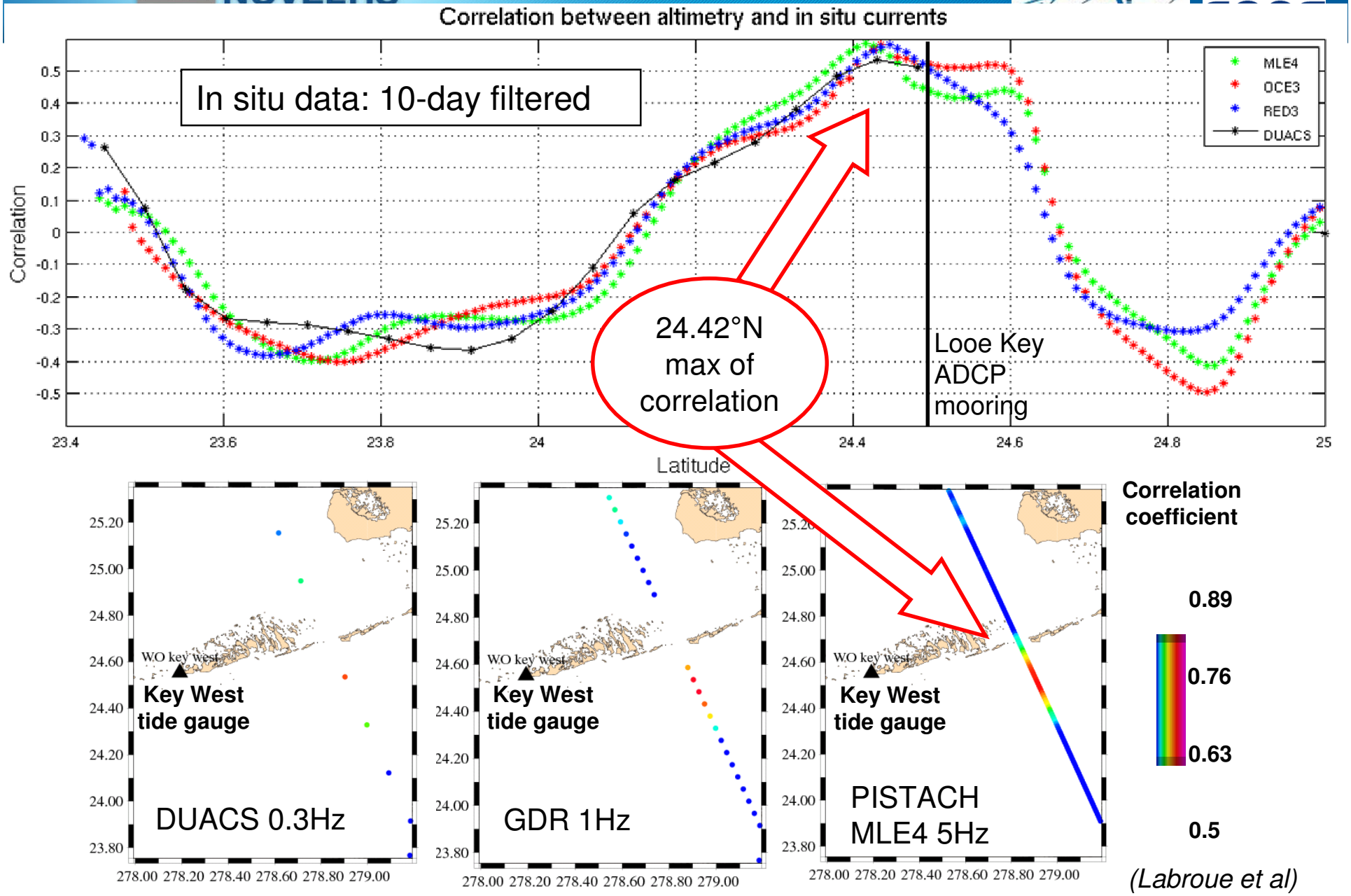
➔Preliminary analyses of the non-filtered SLA are crucial

- Looe Key ADCP mooring (23m depth)
- 14 months in common with Jason-2
  ➔ 44 cycles

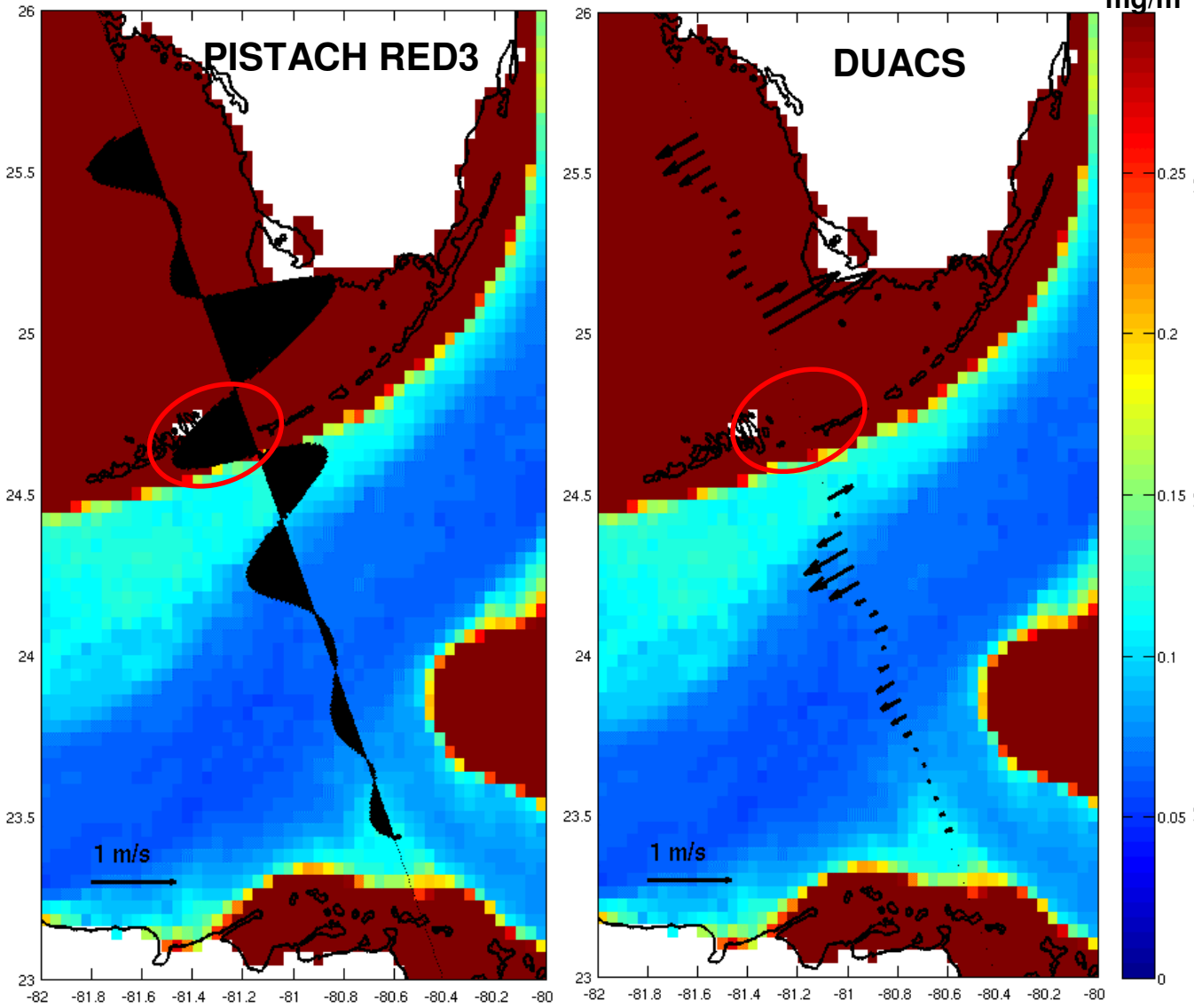




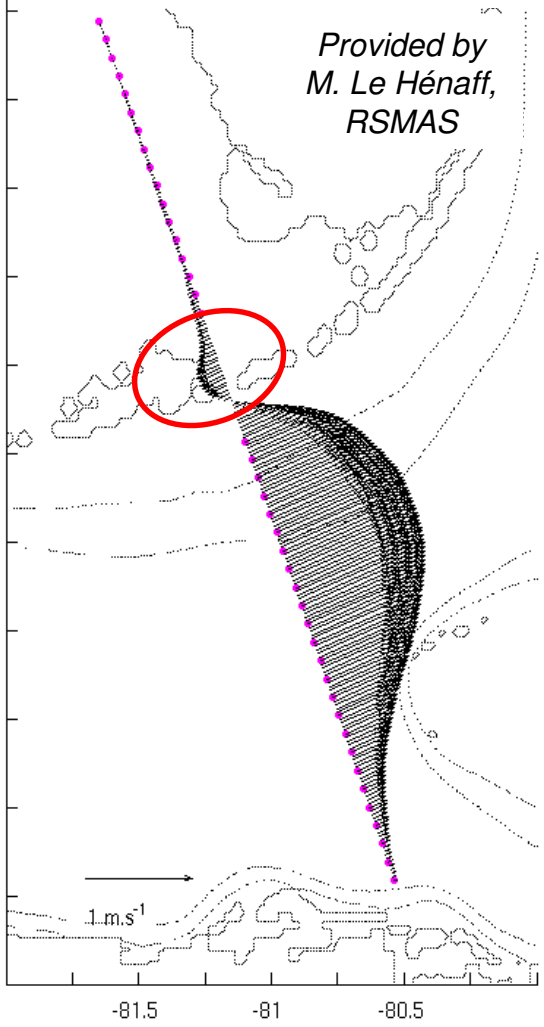
- Data post-processing:
  - 60h low-pass filter
    (Inertial period in the area = 29h)
  - Interpolation at the altimeter measurement dates
  - Projection in the cross-track direction


Correlation between altimetry and in situ currents
In situ data: 10-day filtered
MLE4
OCE3
RED3
DUACS
Correlation
Latitude
24.42°N
max of
correlation
Looe Key
ADCP
mooring
WO key west
Key West
tide gauge
DUACS 0.3Hz
GDR 1Hz
PISTACH
MLE4 5Hz
Correlation
coefficient
0.89
0.76
0.63
0.5
(Labroue et al)

Comparison to ocean color data *(provided by CLS)* – 30/08/2009



Mean geostrophic current – HYCOM model – 30/08/2009



On-going work but…

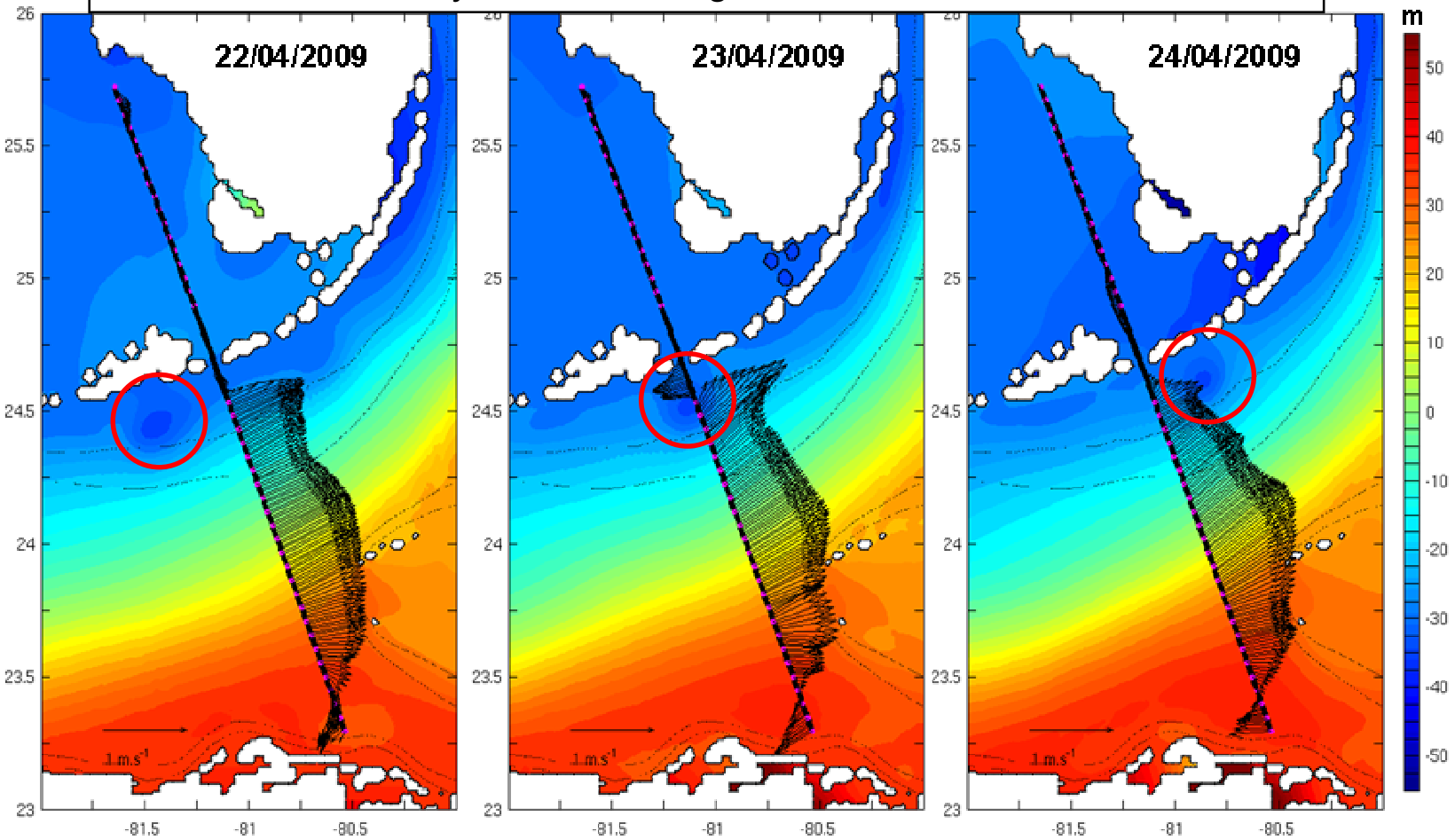
already shows

- The coherency of the signals: altimetry (PISTACH level 3 data), tide gauge and ADCP data
- Some limits of the comparison
  - Position of the ADCP mooring (bathymetry bend)
  - Distance between the altimeter track and the mooring (30 km)
  - Length of the time series (14 months - 44 cycles)
- The synergy between various independent observations and models

Perspectives:

- Focusing on particular events in observations or model outputs

HYCOM Florida Keys SSH w/ alongtrack 5Hz model surface currents



Provided by M. Le Hénaff, RSMAS

Perspectives:

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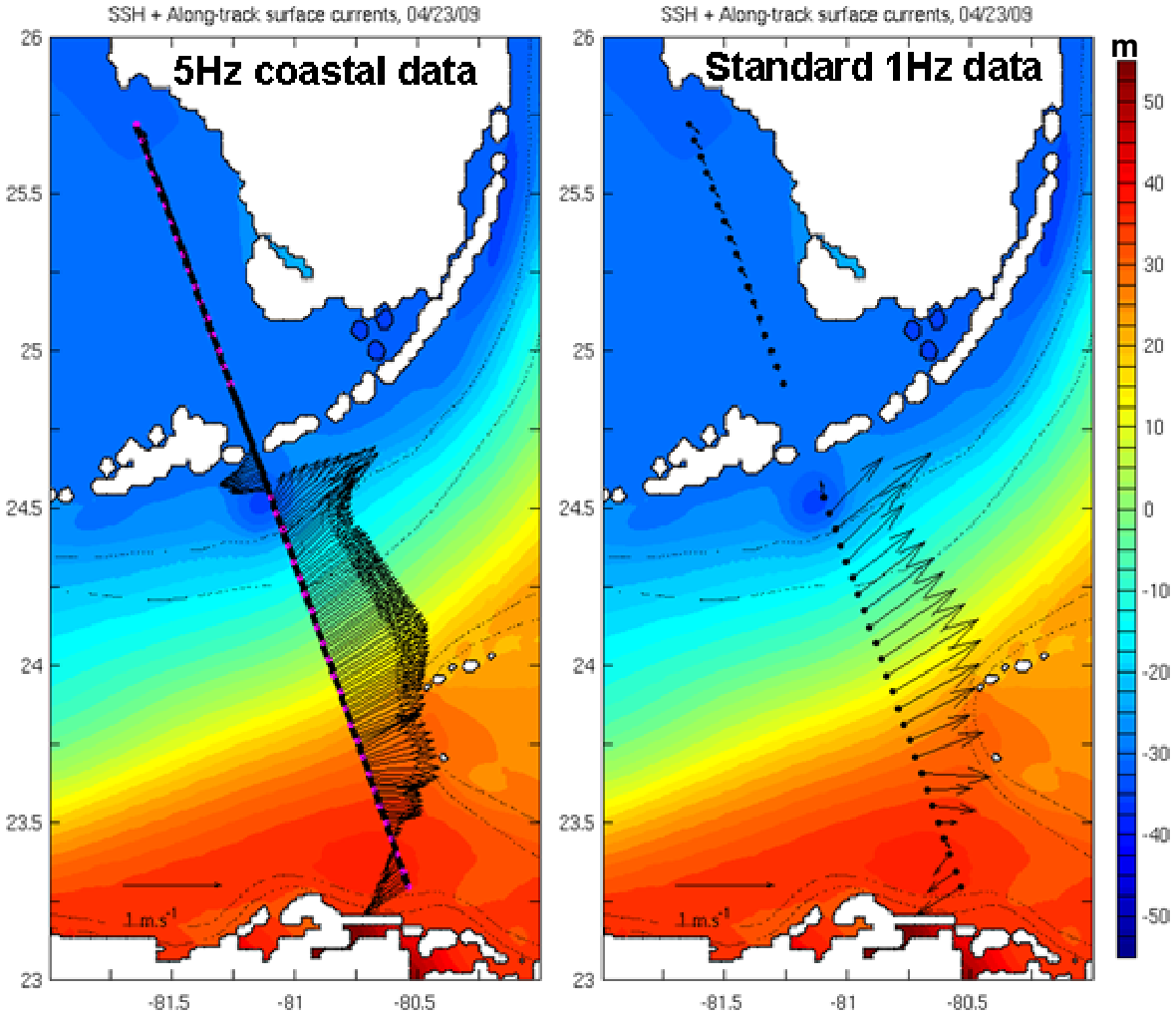


HYCOM Florida Keys SSH w/ alongtrack 5Hz and 1Hz model surface currents

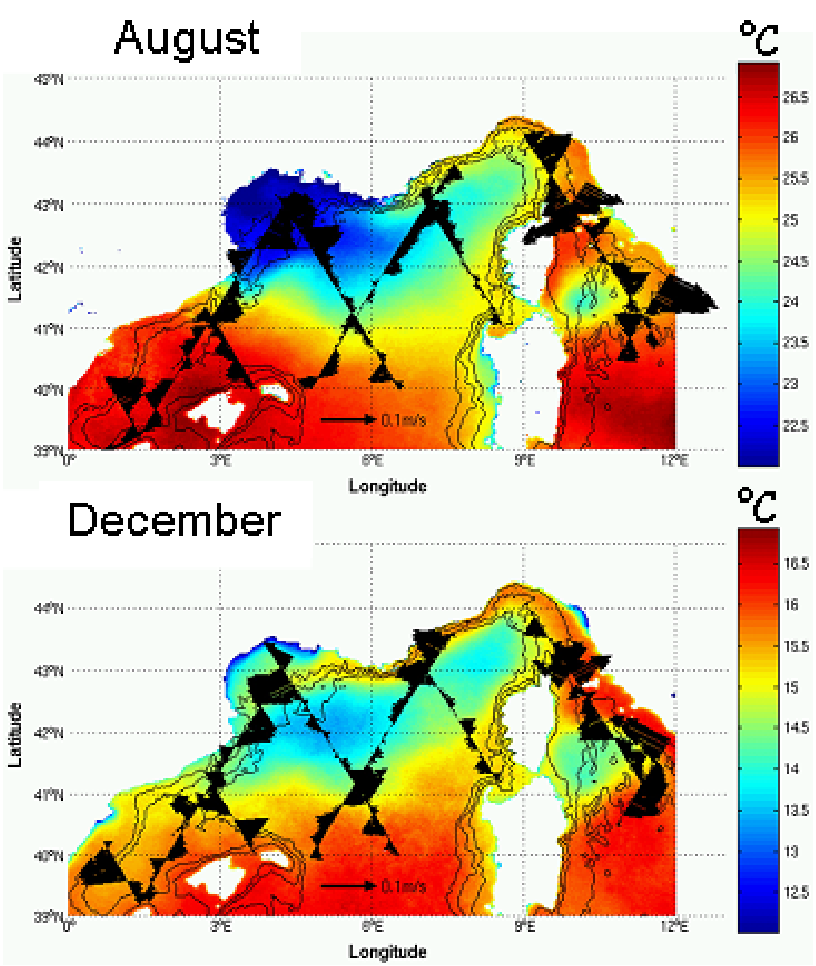
➔ Standard altimetry would miss the eddy

The detection of small frontal eddies is possible thanks to:
- data availability closer to the coast
- high rate data

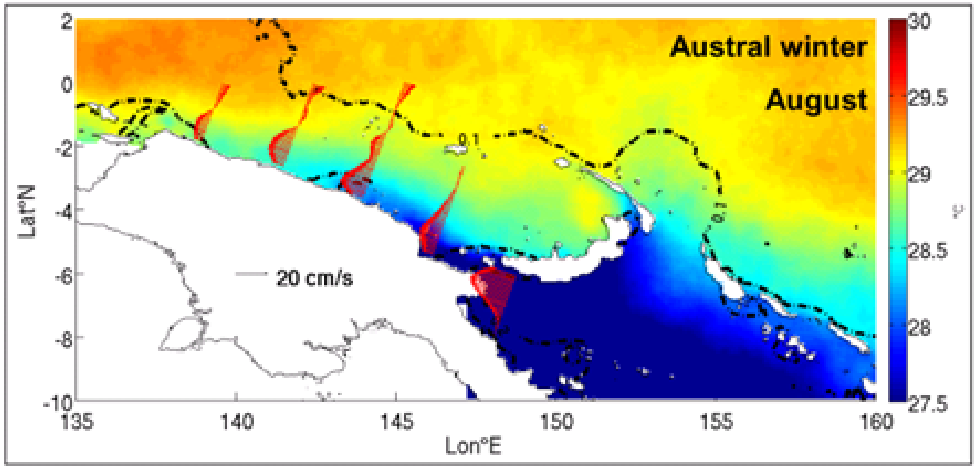
Provided by M. Le Hénaff, RSMAS

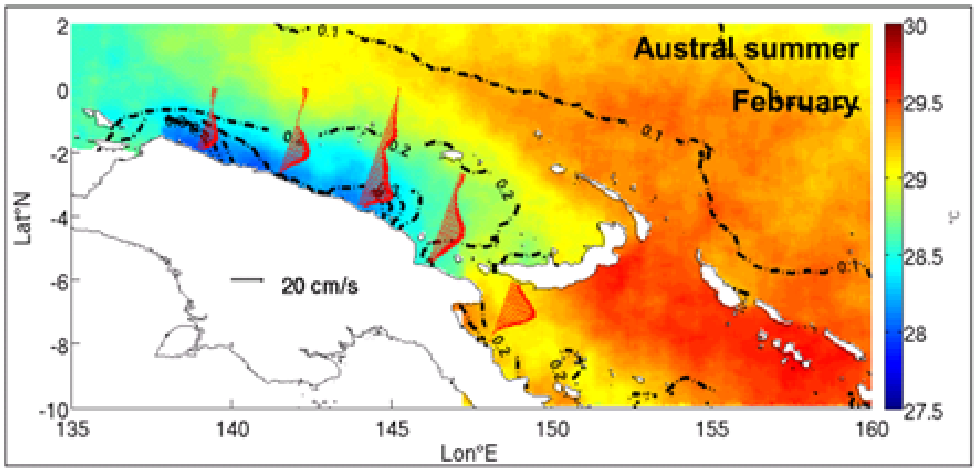
Perspectives:

- Computing climatologies / statistics at long time scales



Birol et al, 2010





Léger et al, 2010

Take-home messages: recommendations for GlobCurrent

- **Observing** the coastal currents and mesoscale structures with altimetry data is improving
  - Coastal 2D-mapping of SLA and currents
  - Coastal altimetry data dedicated processing strategies

  ➔ Real benefit for the users: more data close to the coasts, assimilation in the models, etc…

- **Validating** the coastal altimetry currents is necessary to
  - Quantify the realism of the retrieved SLA and currents, compared to classical products and other types of observations
  - Assess the influence of some parameters on the coastal altimeter data: tide correction, atmospheric forcing, troposphere corrections…

  ➔ Be confident in the data quality

- **Comparing** various kinds of surface current observations implies
  - Different physical contents → homogenization of the data
  - Need for long time series of in situ data, near the altimeter ground-tracks
  - Steady or well-identified geostrophic structures

  ➔ Synergy between the observations