HY-2A and DUACS altimeter products

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Overview

- This study is supported by CNES in the frame of the SALP project.

1. HY-2A satellite characteristics
2. Data and altimeter parameters
3. Validation of available measurements
4. System performances
5. Contribution of HY-2A in DUACS merged maps
6. Conclusions

1. HY-2A satellite characteristics

- HY-2A*: (« Hai Yang »= Ocean)* from the *National Satellite Ocean Application Service (NSOAS; P.R. China)* has been designed for the monitoring of the Ocean dynamics

- HY-2A payloads:
  - Radar altimeter (Ku & C bands)
  - Microwave radiometer (18.7GHz, 23.8GHz & 37GHz)
  - Orbit provided by SLR, GPS & DORIS

- Orbit altitude: ~965 km, sun-synchronous, with 99° inclination
- Repeat cycle: 14 days (for three years) & 168 days

- Satellite launched in August 2011

2. Data and altimeter parameters (1/2)

- Available data:

  1-Hz IGDR cycles 3 and 4 (14 days long cycles) from October 29th to November 26th 2011
- As our **goal** is to derive Sea Level Anomalies from the along-track data of this raw dataset

  ⇒ Altimeter parameters are analyzed

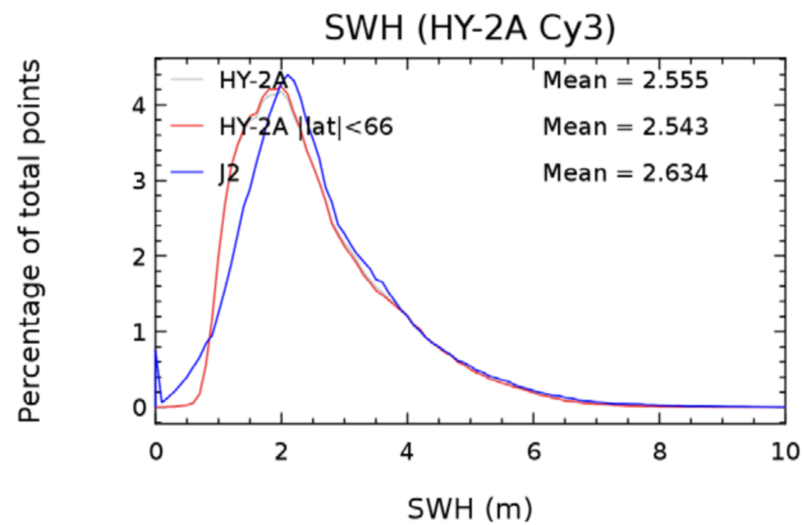
  ⇒ Data need to be validated to exclude deteriorated measurements

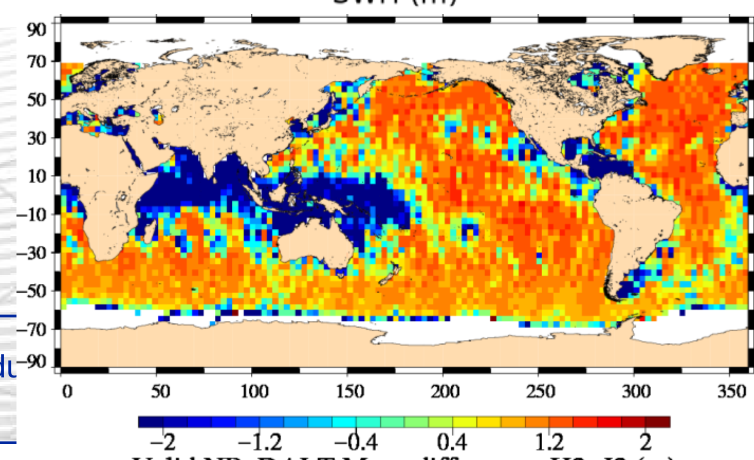
- The analysis of the altimeter parameters indicates that the instrument provides data of good quality.

However, some anomalies are detected , such as:

- A difference of distribution between the histograms of SWH from HY-2A and Jason-2 for values weaker than 3m

- A difference of behaviors of the number of 20Hz measurements between HY-2A and Jason-2 in the Indian equatorial ocean and Indonesia. It affects the number of validated data.

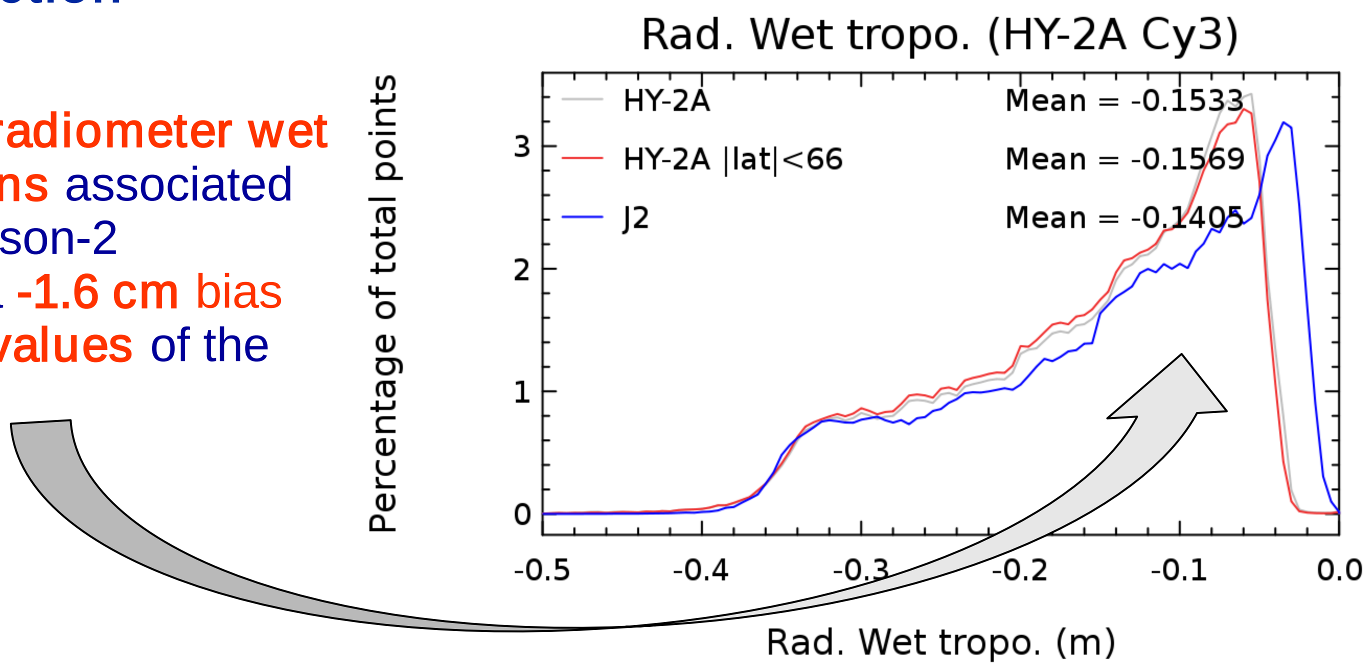




2. Data and altimeter parameters (2/2)

Wet troposphere correction

- The comparison of the **radiometer wet troposphere corrections** associated with valid HY-2A and Jason-2 measurements shows a **-1.6 cm** bias concerning the **lowest values** of the correction.



⇒ Thus, the operational ECMWF wet troposphere correction (provided in HY-2A products) is preferred to compute the HY-2A Sea Level Anomalies

- Indeed, the system performances (SSH variance at crossovers) are improved by 8.8 cm^2 with the use of the model instead of the radiometer

3. Validation of available measurements

- Before computing SLA, data are validated to exclude deteriorated measurements with the DUACS procedure

- The MOE orbit solution is used (because of deteriorated resolution of the datation)

% of rejected measurements	HY-2A	Jason-2
Global	6.8 %	3.6 %
Latitudes < 50°	5.9 %	1.5 %

⇒ The validation procedure of available measurements leads to a **reduced number of available HY-2A data** compared with Jason-2 data

This is in part related with:

- ➢ Default values of altimeter measurements (lead to the rejection of 12.2 % of data)
- ➢ No ice flag is available for HY-2A data

4. HY-2A system performances (1/2)

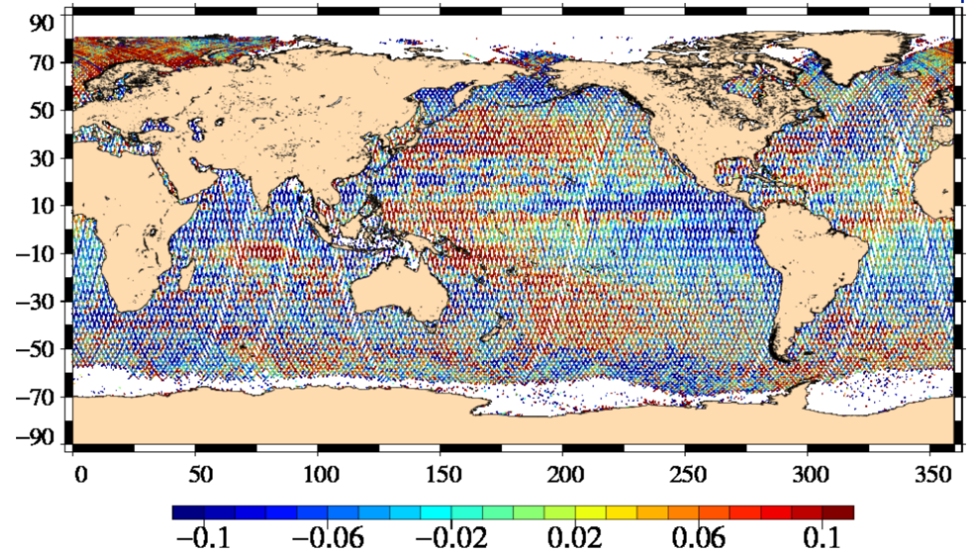
- **Along-track SLA performances**:

⇒ HY-2A along-track SLA performances are slightly deteriorated compared with Jason-2 by 6,0 cm rms (with data selection)

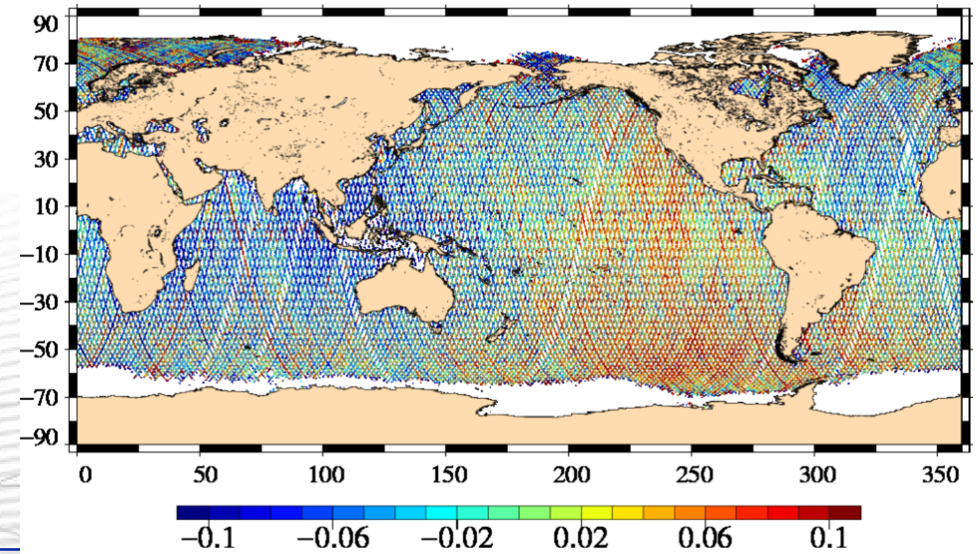
SLA standard deviation	HY-2A	Jason-2
Global	13.6 cm	11.8 cm
Lat<50°, Bathy<-1000m, Ocean Var.<20cm	11.9 cm	10.3 cm

⇒ **SLA differences with DUACS NRT merged products** display **reduced differences** except a basin-scale bias related with the orbit solution

- These results demonstrate the relatively good quality of the HY-2A Sea Level Anomalies



HY-2A SLA (m)



HY-2A SLA – DUACS NRT (m)

4. HY-2A system performances (2/2)

- **Crossover statistics** (<10 d.):
  - It provides a quality assessment of the internal consistency of the mission
  - The higher HY-2A orbit inclination leads to a reduced number of crossover points
  - For the computation, the total level of noise measurement is used for both missions so that results can be compared (J2 values are thus deteriorated compared with usual statistics)

⇒ Global HY-2A statistics value is higher than Jason-2 values (+6,8 cm rms), which represents added energy in the signal

⇒ The difference with Jason-2 is even higher when the data are selected in regions of low ocean variability (+7,9 cm rms), suggesting that the added value of HY-2A is higher in areas of strong ocean variability

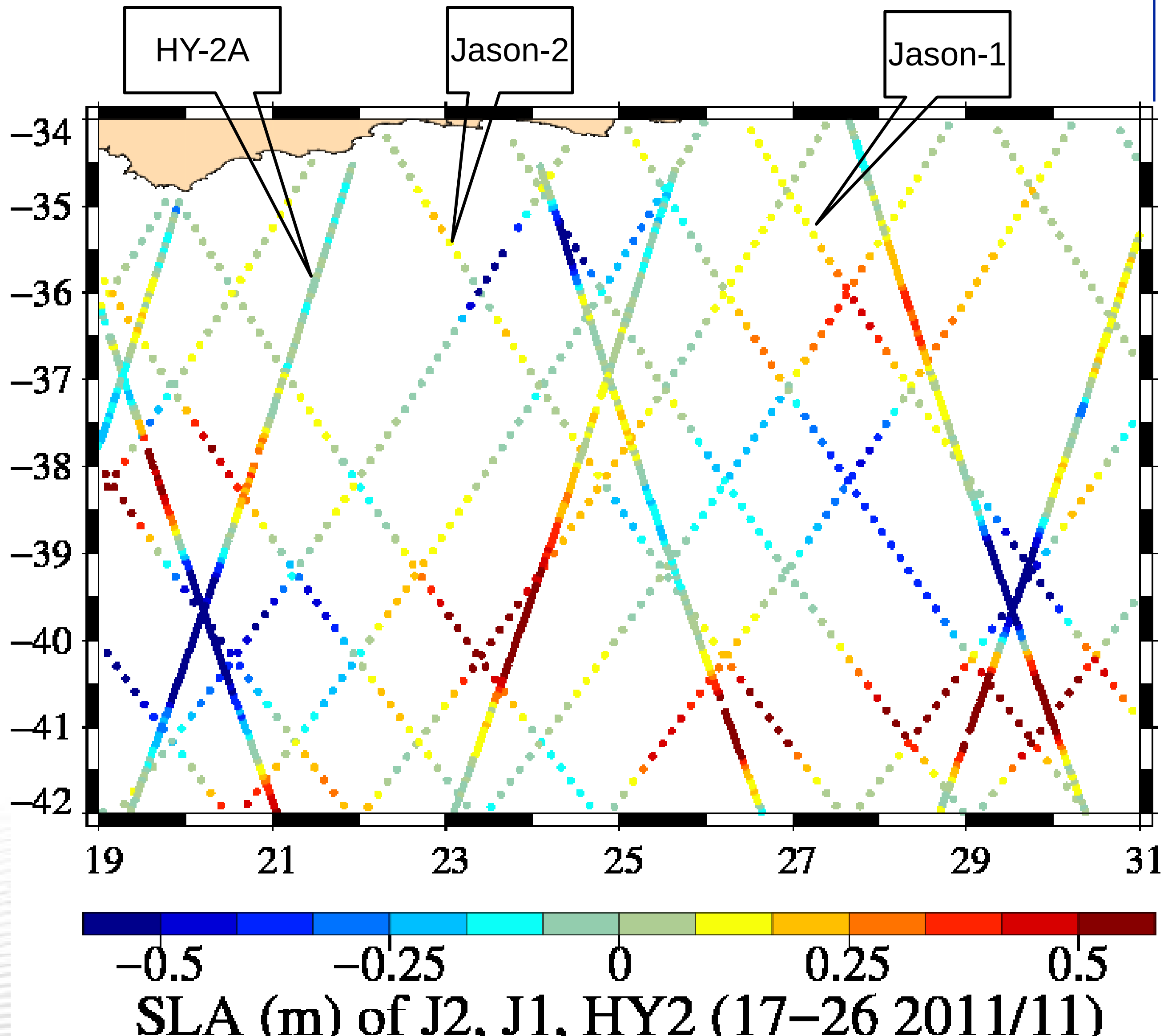
SSH differences	Number of crossover points		Standard deviation	
	HY-2A	*Jason-2*	*HY-2A*	*Jason-2*
Global	12914	31481	11.2 cm	8.9 cm
Lat<50°, Bathy<-1000m, Ocean Var.<20cm	6136	13817	10.0 cm	6.5 cm

5. DUACS merged maps of SLA and HY-2A (1/7)

- DUACS experiment processing:
  - **Goal**: estimate HY-2A L3-L4 data performances in a multi-mission context
  - ➢ Based on the 28 days of HY-2A validated data (2 cycles) + NRT products from other altimeters
  - ⇒ Various multi-missions merged SLA maps are computed via optimal interpolation in NRT mode (it provides a single map of HY-2A SLA using 28 days in the past)

5. DUACS merged maps of SLA and HY-2A (2/7)

- Demonstration in the Agulhas retroflexion current area (stronger mesoscale activity, less sensitive to tropo/iono errors)
- Level 3 SLA products
- **All sensors see very consistent mesoscale features** in this region



5. DUACS merged maps of SLA and HY-2A (3/7)

- Nov. 26th 2011:

  The location of the last 10 days of along-track data from each satellite are superimposed:

  Red dots = Jason-2

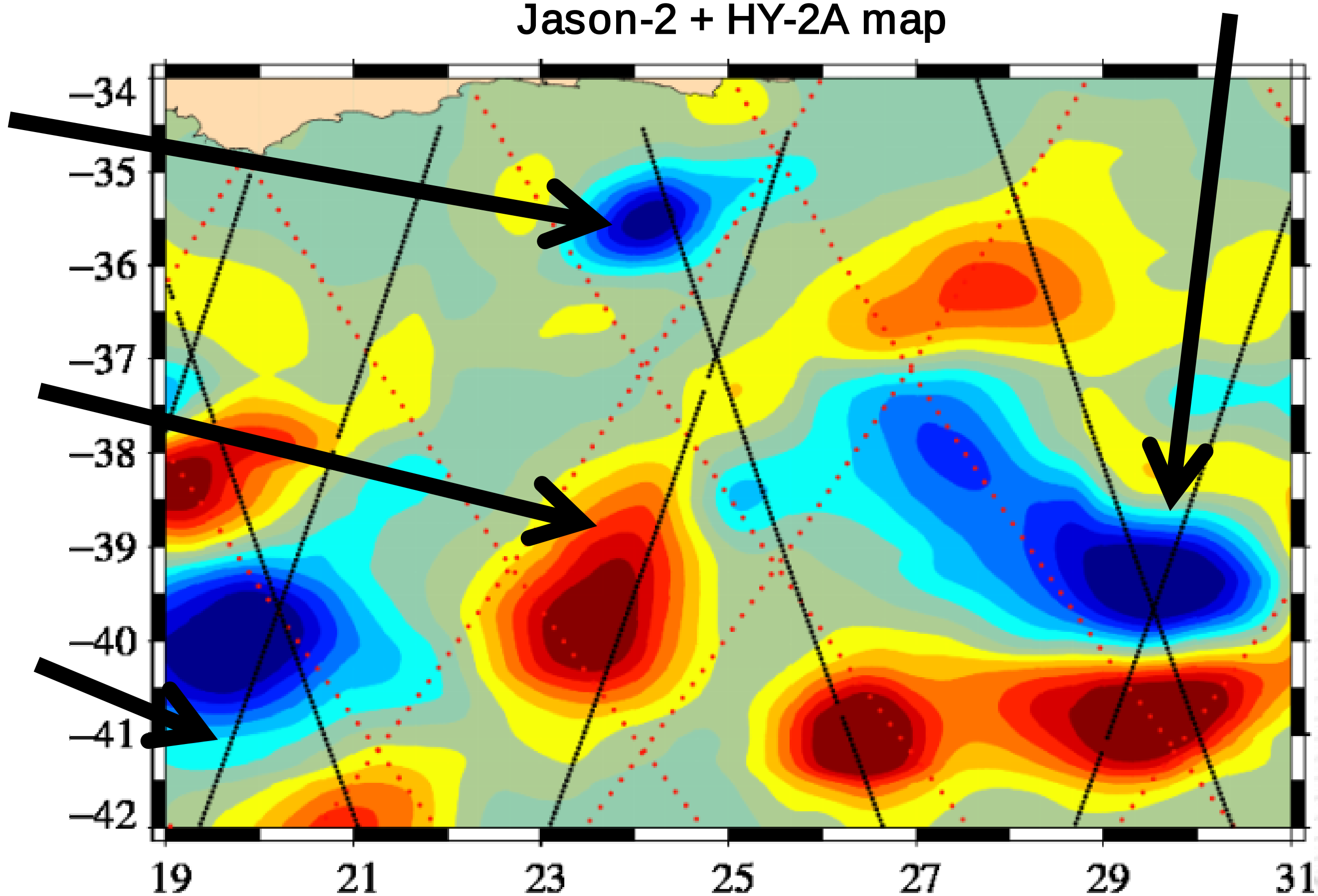
  Black lines = HY-2A

⇒ Adding HY-2A affects the gridded products

⇒ HY-2A can complement the Jason-2 sampling

⇒ The shape and the amplitude of eddies are affected by more than 30 cm

Jason-2 + HY-2A map

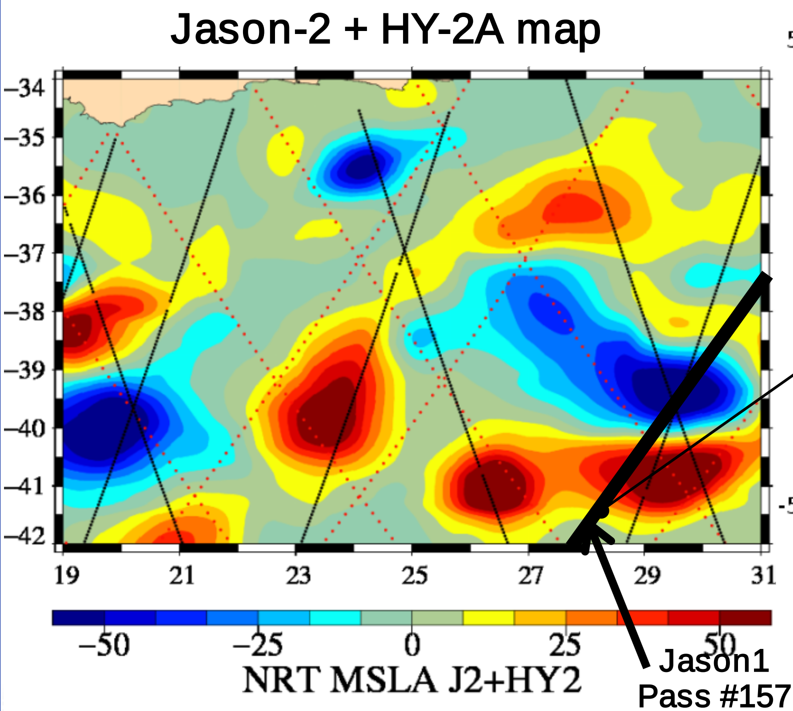


Are the differences significant ?
Are they an improvement ?
Does HY-2A bring useful information ?

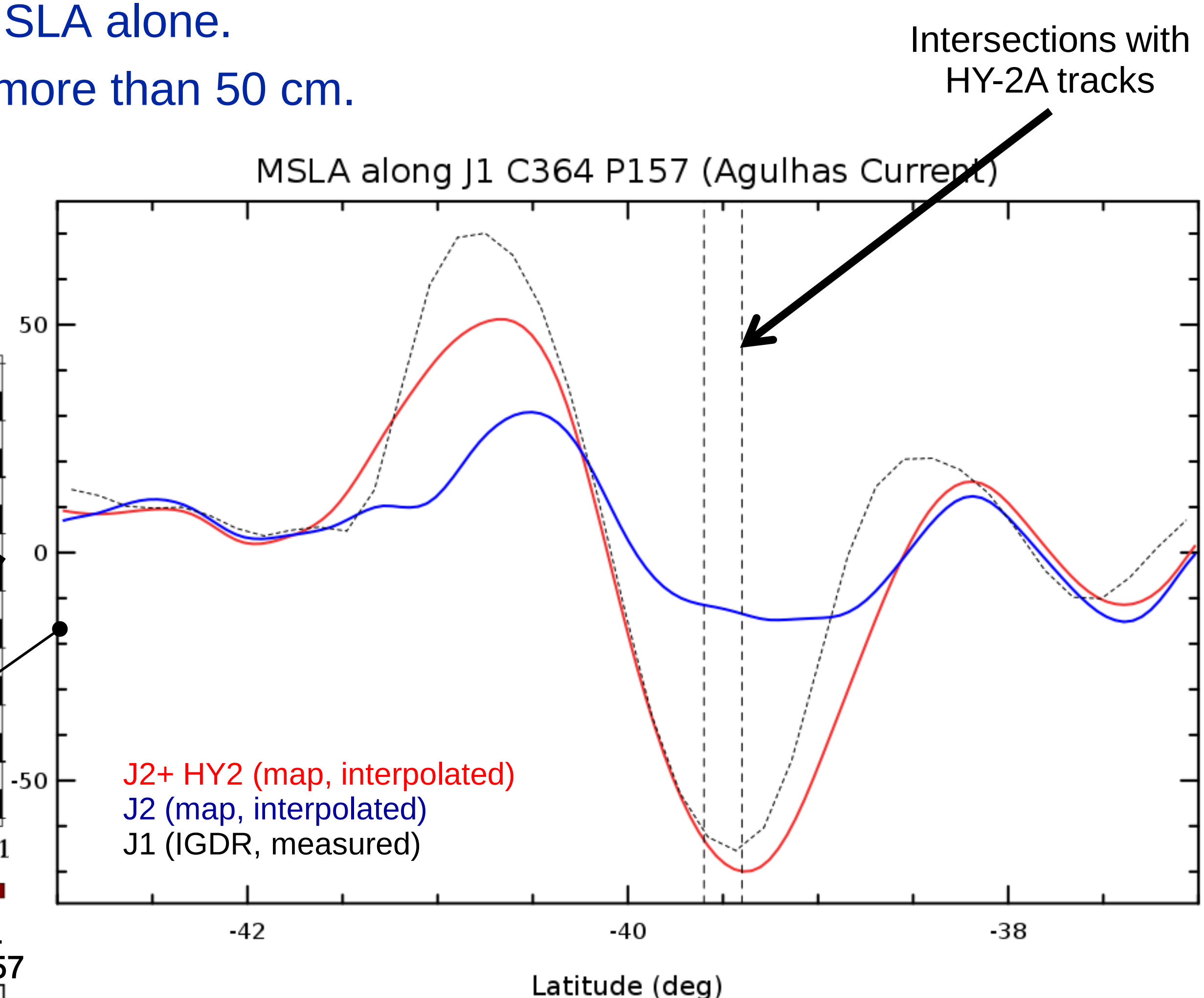
5. DUACS merged maps of SLA and HY-2A (4/7)

⇒ The **use of HY-2A data makes the MSLA more coherent** with Jason-1 rather than Jason-2 MSLA alone.

⇒ Eddy amplitude is affected by more than 50 cm.



Nb of data	:	1110	St. Dev	:	22.0944785	Skewness	:	–0.0764474	Minimum	:	–68.5820999
Mean	:	3.5730622	Rms	:	22.3815270	Kurtosis	:	1.5308972	Maximum	:	75.4492035



5. DUACS merged maps of SLA and HY-2A (5/7)

- Maps from J2 (alone) or J2 + HY2 are interpolated under all Jason-1 tracks available in the area (along-track IGDR, true reality, measured and independent from maps)
- The analysis is restricted to seven Jason-1 tracks which temporally differ from the map by 0 to 7 days in the past
- The differences between the interpolated maps values and the independent Jason-1 measurements are computed for each Jason-1 track

⇒ The use of **HY-2A** data **improves the MSLA estimation by 6 cm rms on average** compared with the use of Jason-2 MSLA only

⇒ In case of a Jason-1 track going through an eddy, this improvement can reach 8 cm RMS

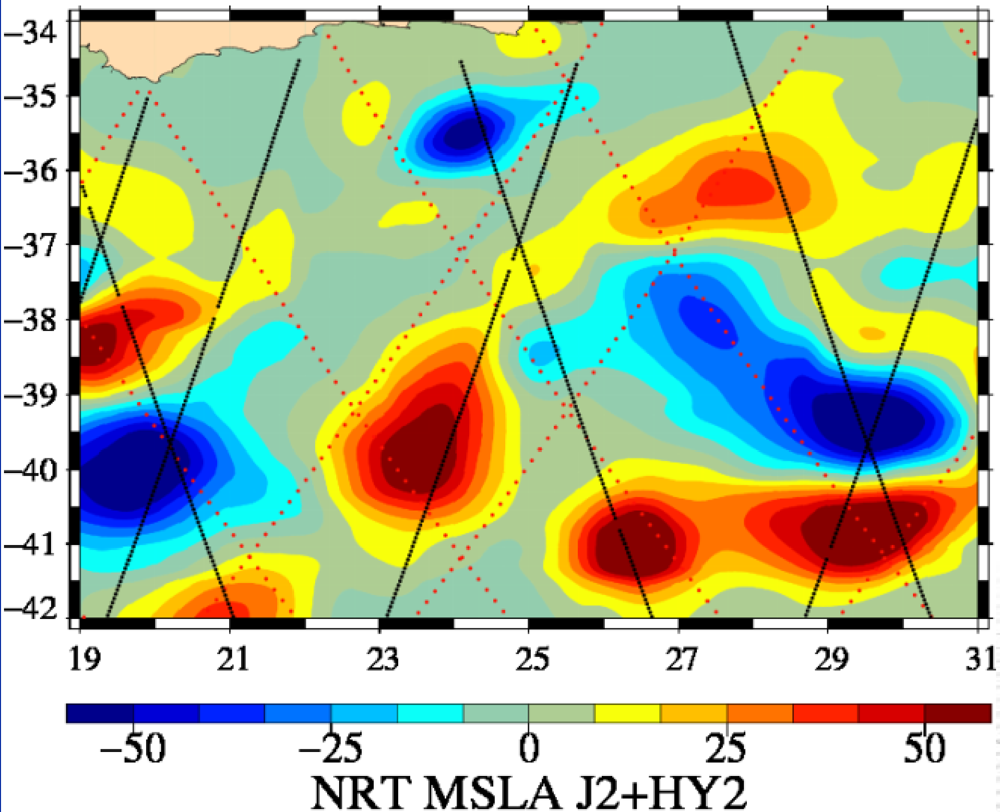
⇒ The improvement is very significant !

5. DUACS merged maps of SLA and HY-2A (6/7)

- **Question: Is this contribution as good as the one of other altimeter?**
- Qualitatively and in the studied region, we illustrate that when HY-2A is added to Jason-2, eddies are better resolved and more coherent with the map from Jason-2 + Jason-1:

Red dots = Jason-2, Blue dots = Jason-1, Black lines = HY-2A

Jason-2 + HY-2A map



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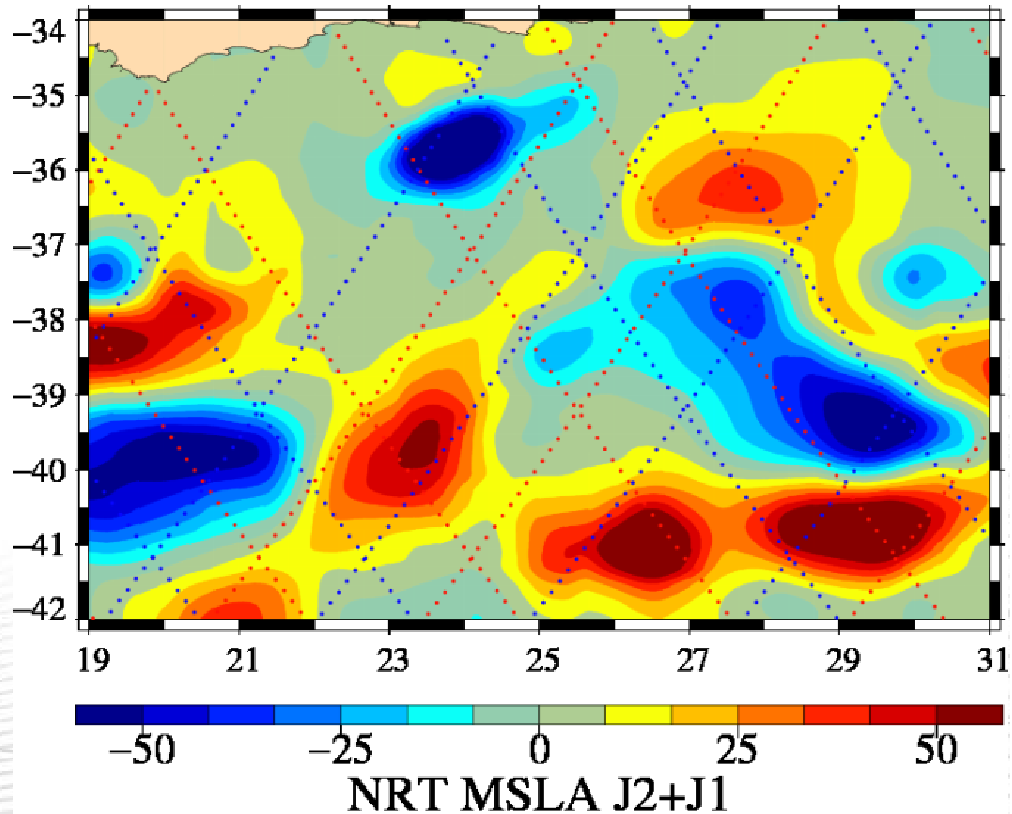
Jason-2 + Jason-1 map



Nb of data	:	1110	St. Dev	:	23.119564	Skewness	:	−0.330583	Minimum	:	−85.632599
Mean	:	4.497605	Rms	:	23.552976	Kurtosis	:	1.392910	Maximum	:	74.936798

5. DUACS merged maps of SLA and HY-2A (7/7)

- We have shown that in some regions, the HY-2A contribution can be significant
- **Question: To which extent HY-2A can secure the altimeter constellation?**
- Performances of various satellites configurations are estimated by computing global MSLA differences between 2 satellites maps and the « reference » (Jason-2) map alone:

MSLA maps differences	(J2+J1) – J2	(J2+Envisat) – J2	(J2+HY2A) – J2
Rms (cm)	3.15	3.10	2.81

⇒ Jason-2 + Jason-1 is the optimal 2 satellites configuration

⇒ Jason-2 + Envisat is less optimal but the associated error is estimated to be rather weak

⇒ The Jason-2 + HY2 configuration is less optimal since the rms of the difference with Jason-2 is smaller than the other configurations

⇒ Results are obtained with a preliminary dataset

⇒ **With some improvements of the data and of the processing, HY-2A could provide very promising results and potentially replace Envisat or Jason-1!**

Conclusions

- Available preliminary HY-2A data do not have yet the accuracy of Jason like mission, but…
  - The altimeter system show promising performances
  - HY-2A can complement the sampling of current missions
  - It can provide valuable information on the ocean mesoscale variability particularly in regions of strong ocean variability

- With adapted evolutions on the processing of the altimeter data, **HY-2A could provide very promising results concerning the observation of the sea level**

- **Updated results:** HY-2A cycle 21 (July 2012) has just been available!

  The along-track SLA performances are higher than Jason-2 associated values by 4.5 cm rms whereas it was higher by 6.0 cm rms over cycles 3 and 4.

  ⇒ **Improved performances are observed!**