



CENTRE NATIONAL D'ÉTUDES SPATIALES

Cryosat Processing Prototype (CPP)

CRYOSAT LRM, TRK and SAR Processing

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To prepare the CNES proposed SAR retracking for Sentinel-3 mission, CNES decided to take the opportunity of the availability of CRYOSAT/SIRAL data:

- ⇒ To develop and test processing methods of SAR data over ocean,
- ⇒ To assess SAR processing performances,
- ⇒ To define how to ensure data quality continuity between SAR and LRM measurement modes.
- ⇒ To define how to provide a LRM reference during SAR mode (LRM-Looklike measurements).

To achieve those goals,

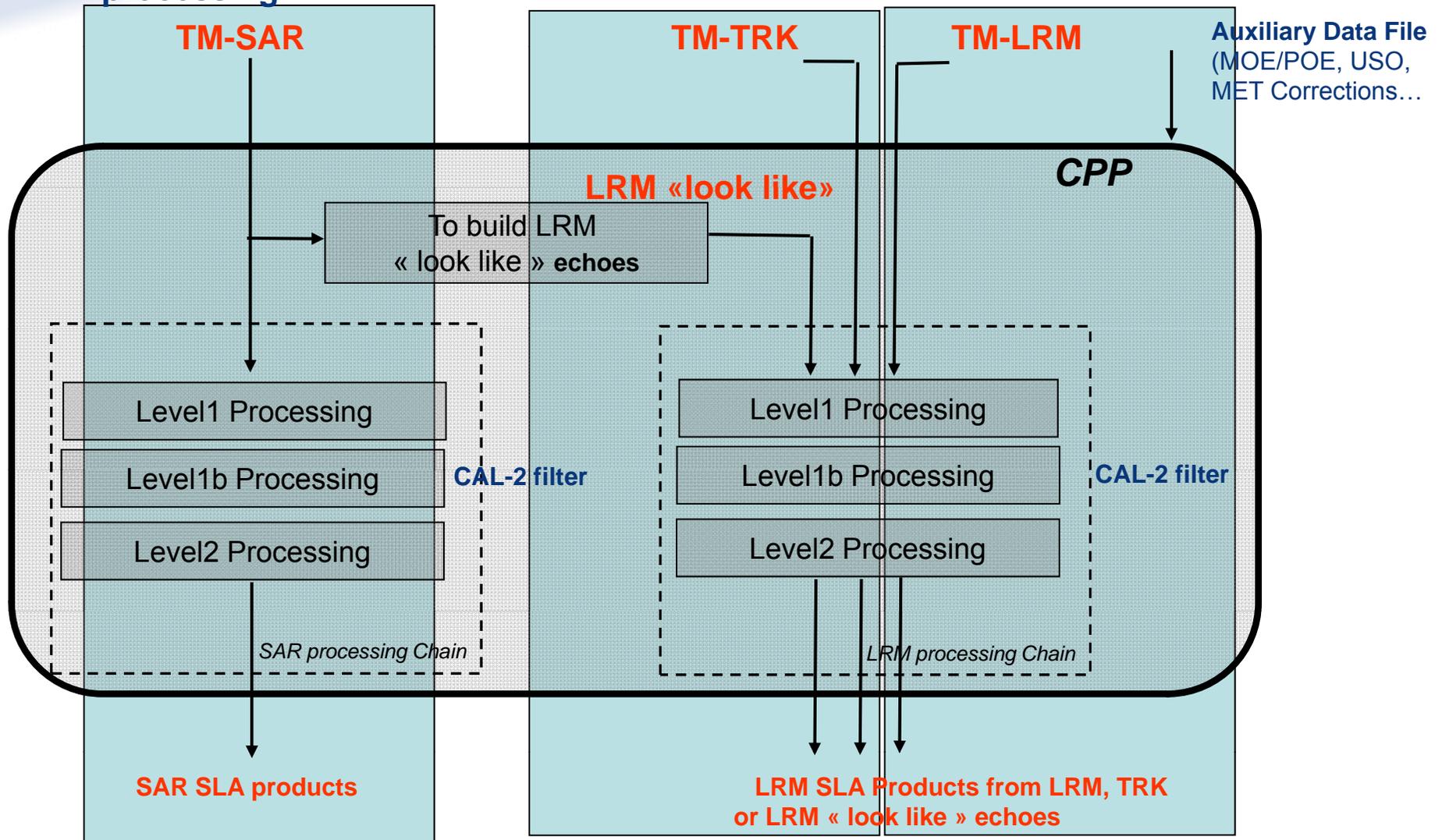
- ⇒ CNES started the development of a processing module of CRYOSAT data CPP (CNES CRYOSAT Processing Prototype).
- ⇒ Access to LRM/TRK/SAR data has been kindly granted by CryoSat project. Knowing that the CNES processing results are not to be distributed outside the S3 project team.

CPP Interfaces and Architecture

Core Objective :
To perform SAR processing

To provide a LRM reference during SAR mode

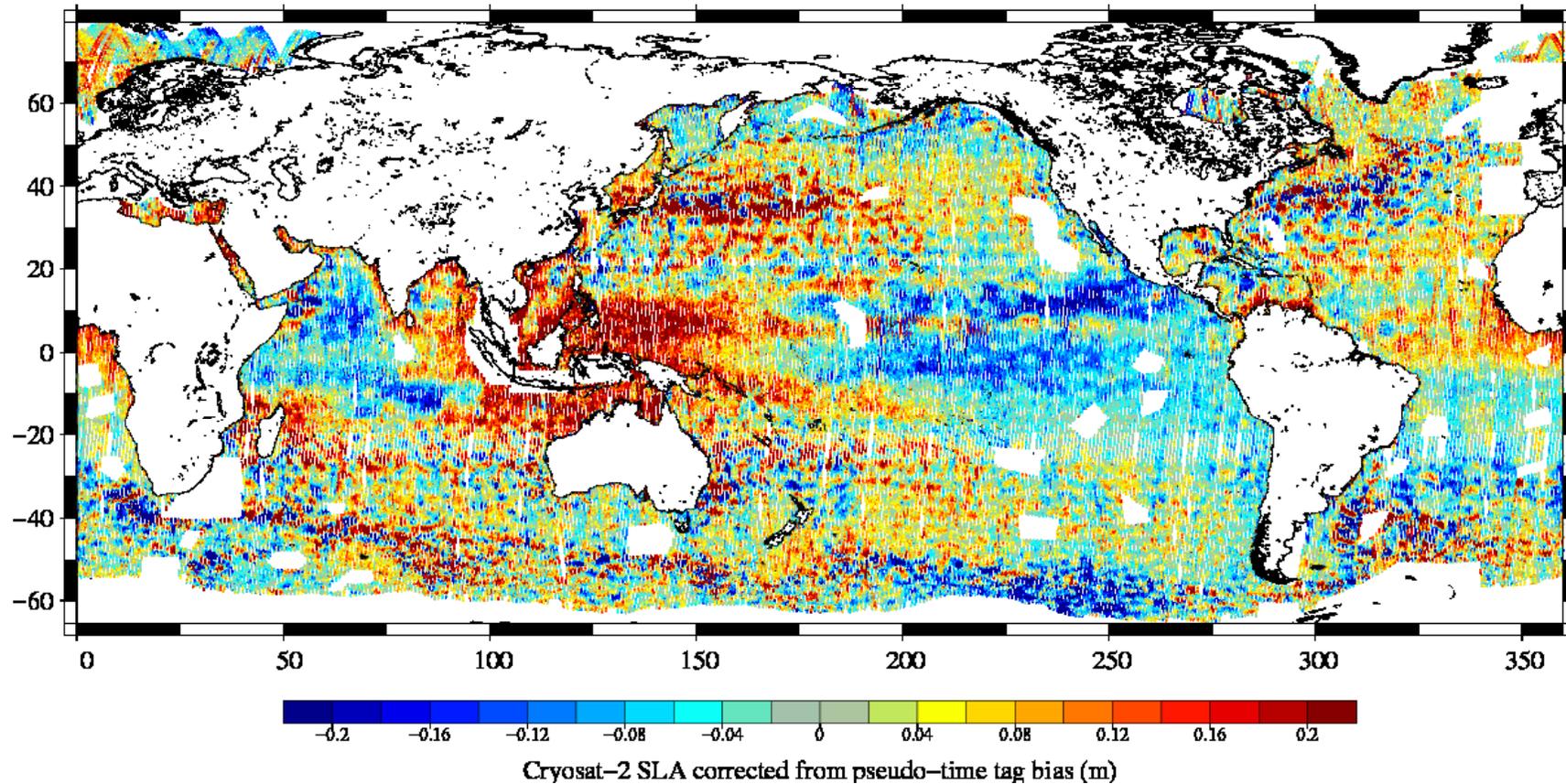
To analyze continuity between LRM <-> SAR



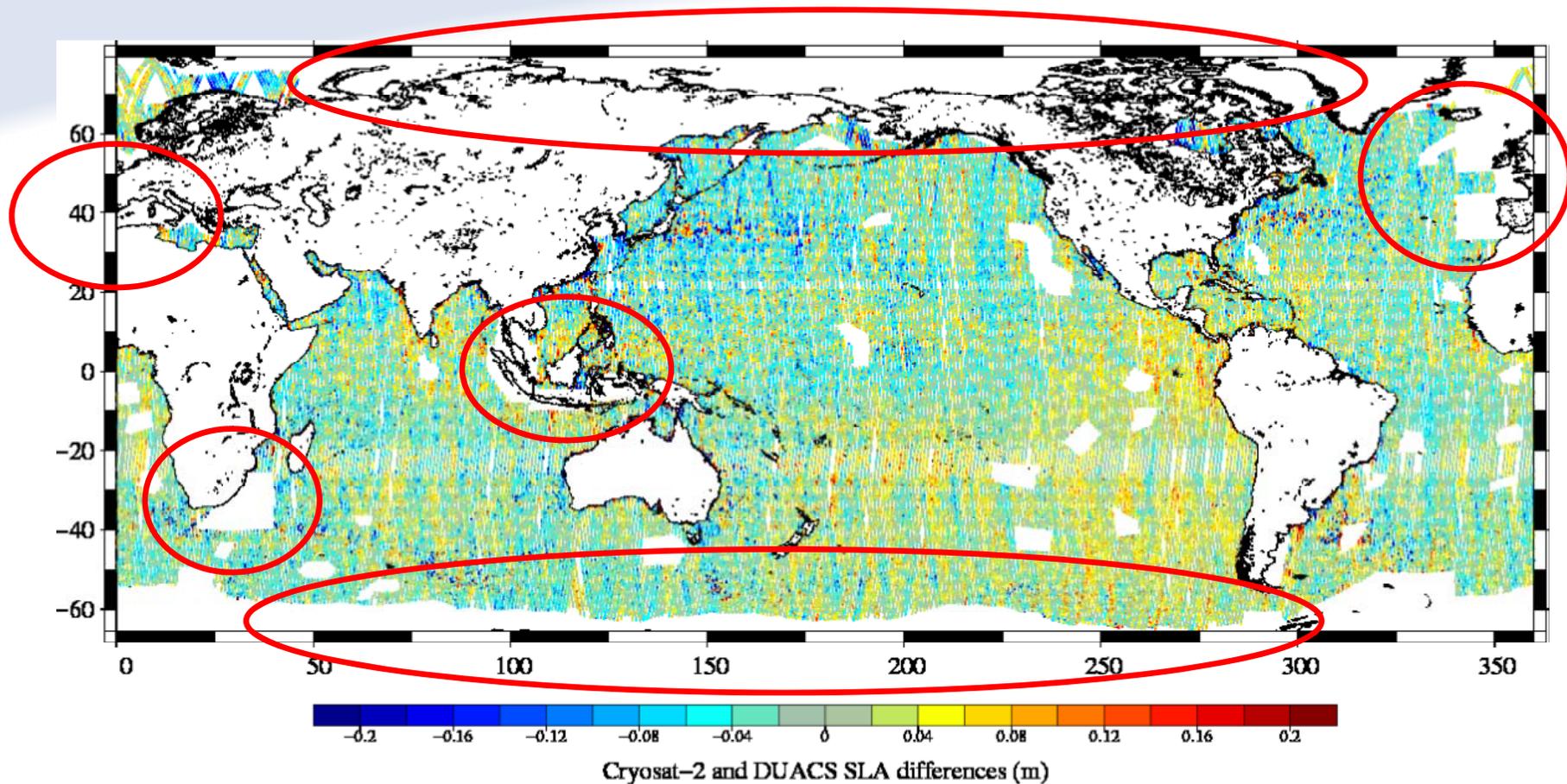
CRYOSAT SLA values from LRM measurements (1/2)

Results:

CRYOSAT SLA grids (respect to the MSS) over December, 2010.



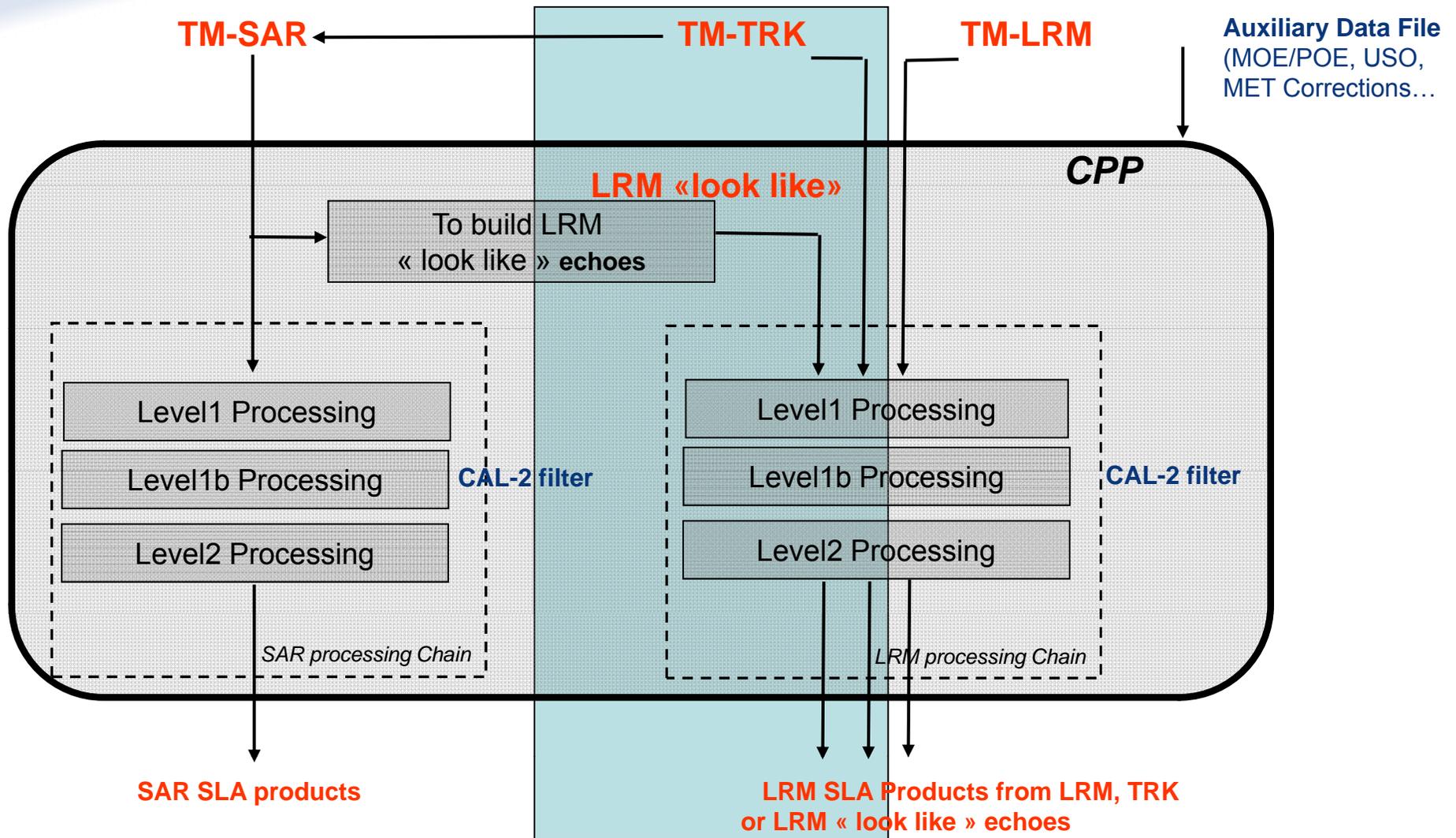
CRYOSAT SLA values from LRM measurements (2/2)



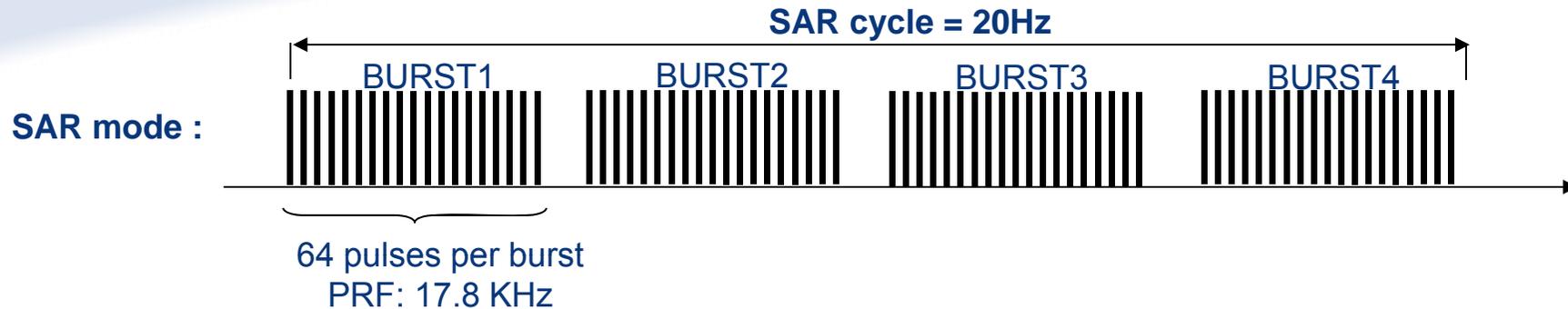
See S. Labroue's Poster: « First quality assessment of the CRYOSAT-2 Altimetric System over ocean »

CPP Interfaces and Architecture

To provide a LRM reference during SAR mode



How to provide a LRM reference during SAR mode?



How to provide with a LRM reference during SAR mode?

1. TRK echoes :

On-board echoes generated by the altimeter during SAR mode to perform the tracking measurement (Available in TM-TRK files). Accumulation of 1 every 9 pulses in each BURST
 → Total of 32 pulses

Approximation: pulses are not corrected for radial velocity (HPR) inside the BURST. Pulses slide inside the altimeter window.

2. LRM-Looklike echoes:

On-ground echoes generated from SAR telemetry.

Possibility to accumulate configurable ratio of pulses (1/2, 1/4, 1/9, 1/8...).

No approximation: correction of the radial velocity before accumulation.

Questions raised:

What is the best accumulation ratio to reach the best range and SWH noise level?

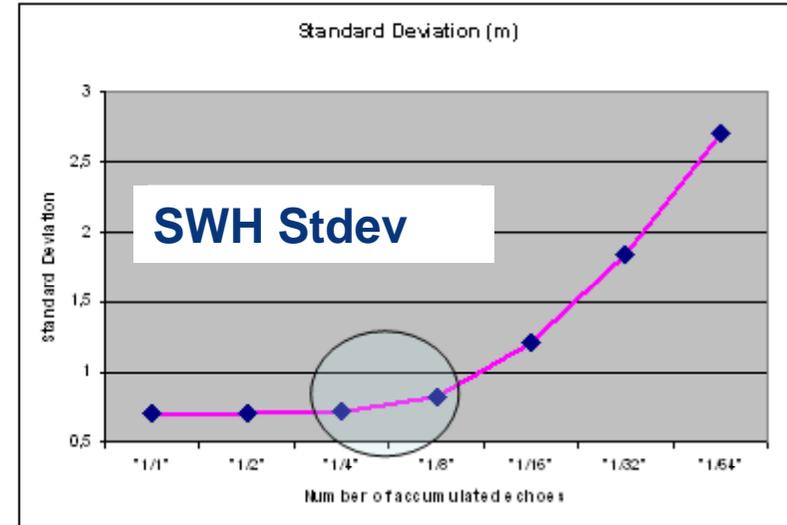
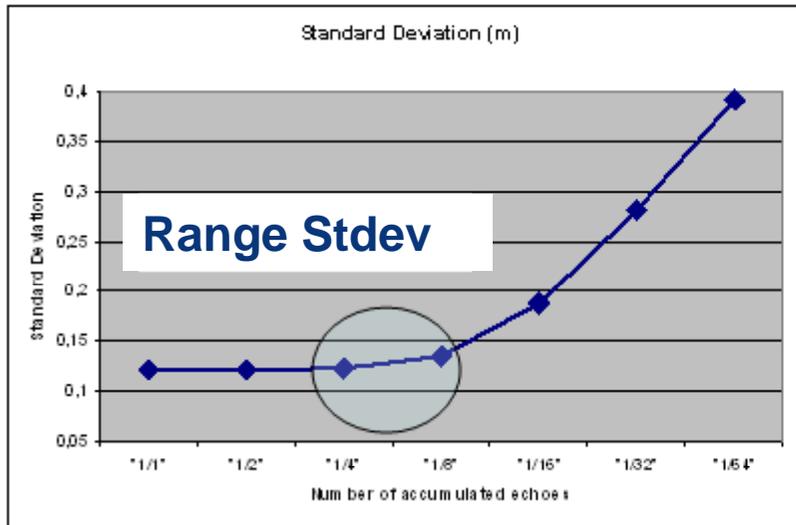
What is the impact of the on-board SAR tracker approximation (no HPR correction)?

How to provide a LRM reference during SAR mode?

What is the best accumulation ratio to reach the best range and SWH noise level ?

Method: Processing of one pass (SWH=6m) of LRM-looklike echoes with different accumulation ratio (1/2, 1/4, 1/8 ...). Comparison of SWH and Range noise level for each accumulation ratio.

Results:



Conclusion:

Best ratio = 1/8 or 1/4 (corresponding to $2.25\text{kHz} < \text{PRF} < 4.5\text{kHz}$ → Correlation frequency threshold).

	"1/8"	"1/9"	"1/4"	POS3
Number of accumulated echoes	32	32	Ratio = 3	90
Corresponding LRM PRF (kHz)	2,25	2	=	2
Range Stdev (cm)	13,5	13.7	Ratio = sqrt(3)	8
SWH Stdev (cm)	82,5	84.9		45

How to provide a LRM reference during SAR mode?

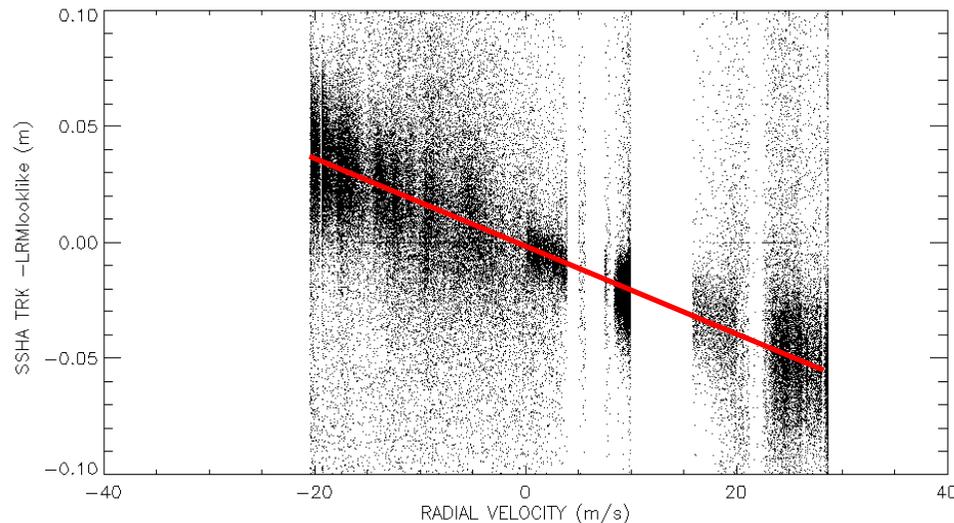
What is the impact of the on-board SAR tracker approximation (no HPR correction)?

Processing of one day of TRK echoes and LRM-looklike echoes (with ratio=1/9)

Comparison of range and SWH estimations and noise level.

Results:

- No differences for SWH values (< 1cm)
- Same Range and SWH noise level: TRK noise level is slightly lower!
- **High Range differences: +/-5cm**
 $\text{Range_Dif} = - (\text{Radial_Velocity} \times \text{BURST_duration}) / 2$



Conclusion:

To provide a LRM reference during SAR, **TRK echoes can be used:**

The 1/9 accumulation ratio provides a good range and SWH noise level.

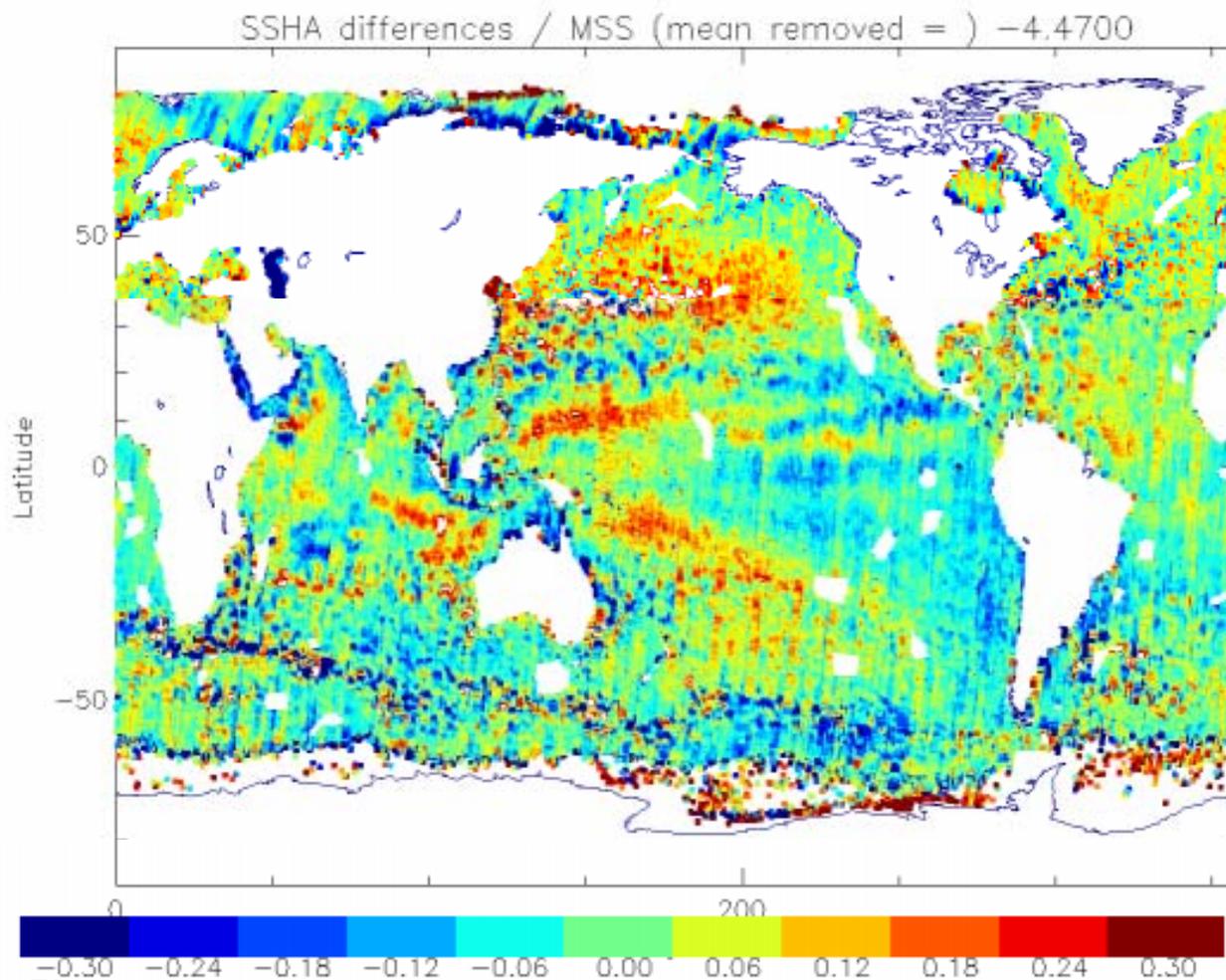
SWH values are correct.

But Range values must be corrected for the vertical speed.

CRYOSAT SLA values from **TRK measurements (1)**

Results:

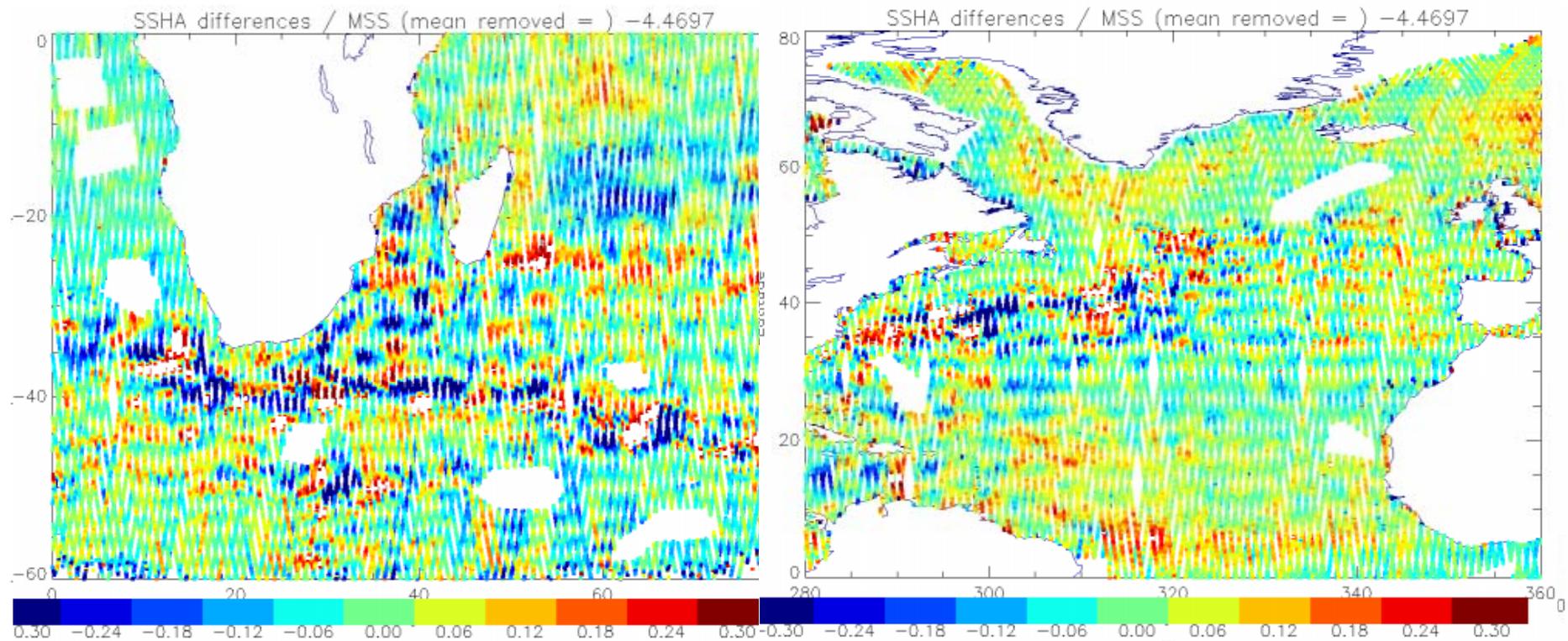
CRYOSAT SLA grids (respect to the MSS) over August, 2011 from TRK and LRM



CRYOSAT SLA values from **TRK measurements (2)**

Results: focus on Agulhas current and Atlantic

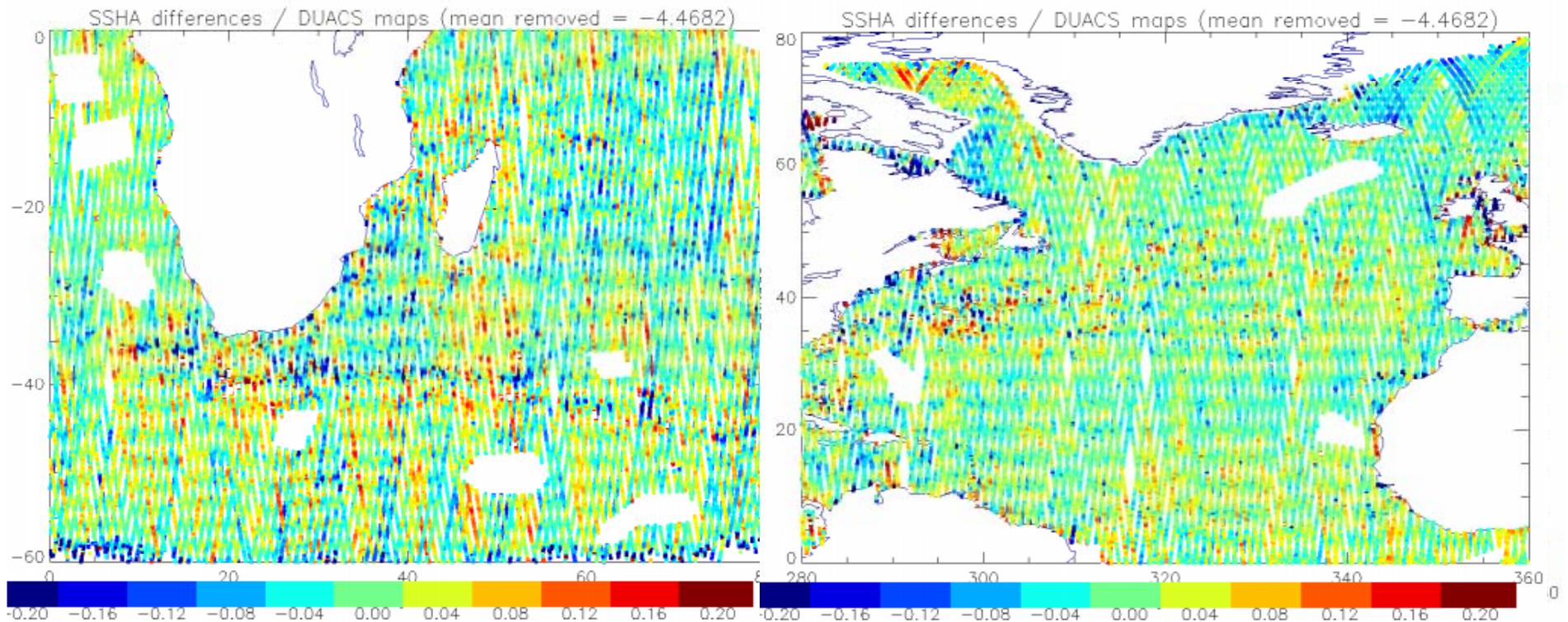
CRYOSAT SLA grids (respect to the MSS) over August, 2011 from TRK and LRM



CRYOSAT SLA values from **TRK measurements (3)**

Results: focus on Agulhas current and Atlantic

CRYOSAT SLA grids (differences with DUACS) over August, 2010 from TRK and LRM



Very good continuity between CRYOSAT TRK and LRM SLA.

To perform SAR processing

Activities on-going...

Studies have been started by CNES mid of 2011 with CLS to develop a SAR Retracking method.

See next P.Thibaut talk:

SAR Data over Ocean, Processing Strategy and Continuity with LRM Data.

Two different approaches are analyzed:

1. SAR Retracking using an analytical model:

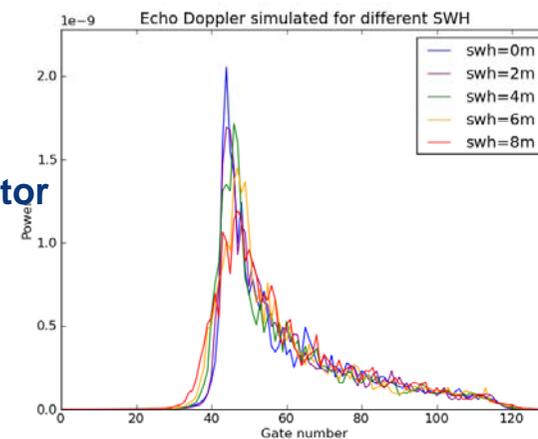
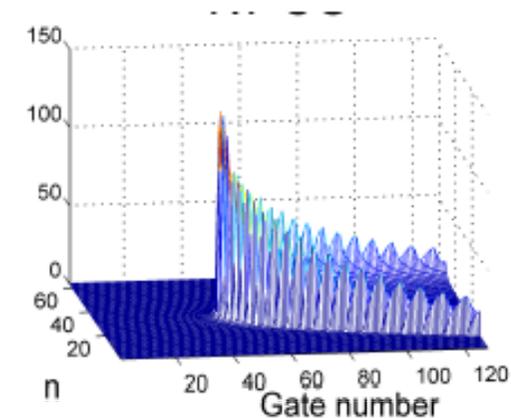
PhD A. Halimi (IRIT/INT-ENSEEIH)

2. SAR Retracking using numerical model

Modeling of a SAR/Doppler echo

Development of a SAR/Doppler altimeter simulator

Development of a numerical retracking



- **CRYOSAT LRM processing chain:**

- ⇒ Same level of accuracy than J2/ENVISAT mission

- **CRYOSAT LRM looklike processing chain:**

- ⇒ To provide a LRM reference during SAR mode

- ⇒ TRK data can be used but range must be corrected

- ⇒ Very good data quality continuity between LRM and LRM looklike SLA

- **CRYOSAT SAR processing chain:**

- See P. Thibaut next presentation

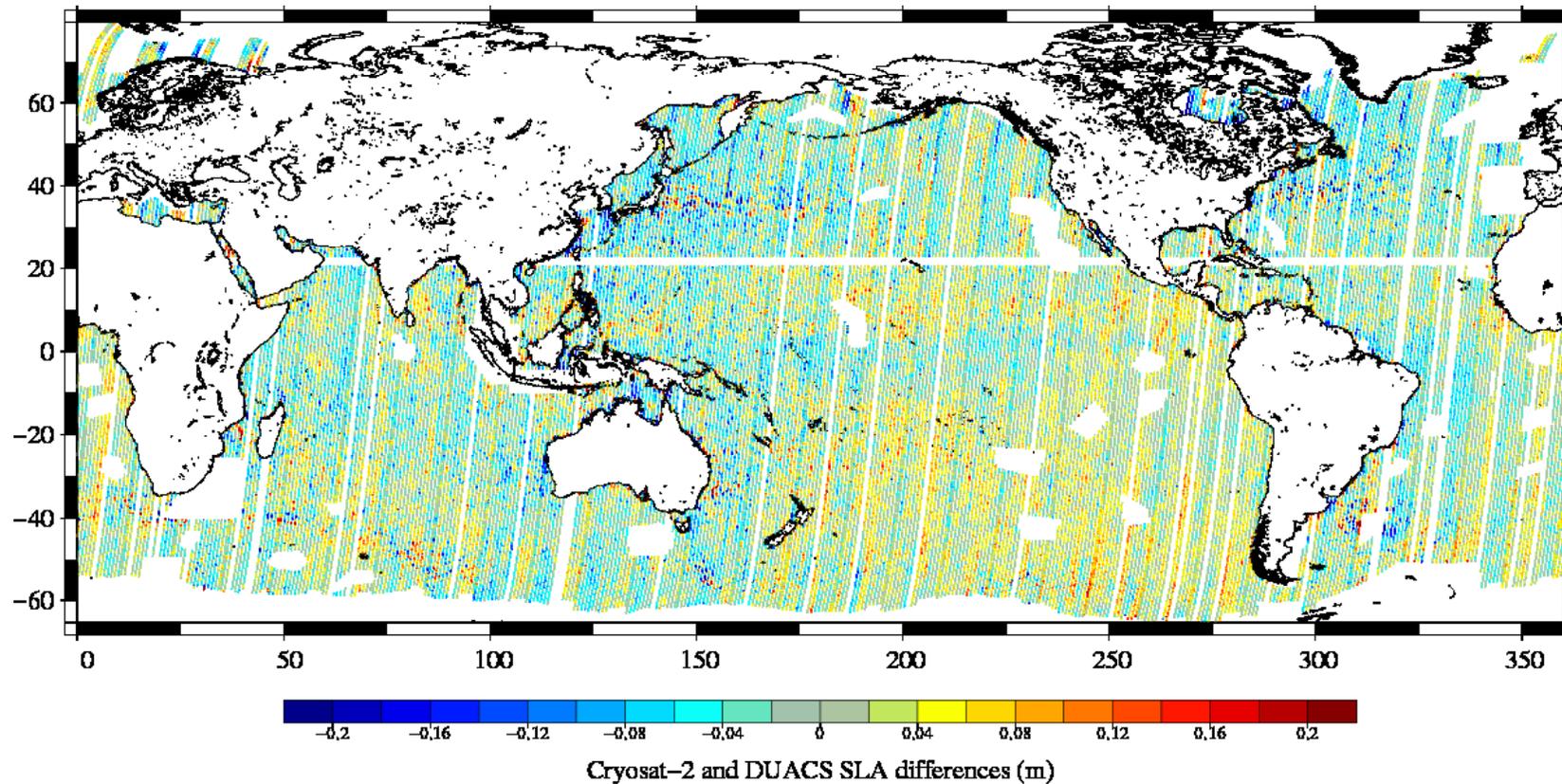


Annex :

CRYOSAT SLA values from LRM measurements (3)

Results:

*CRYOSAT SSHA grids (respect to the MSS) over December, 2010.
Ascending passes.*

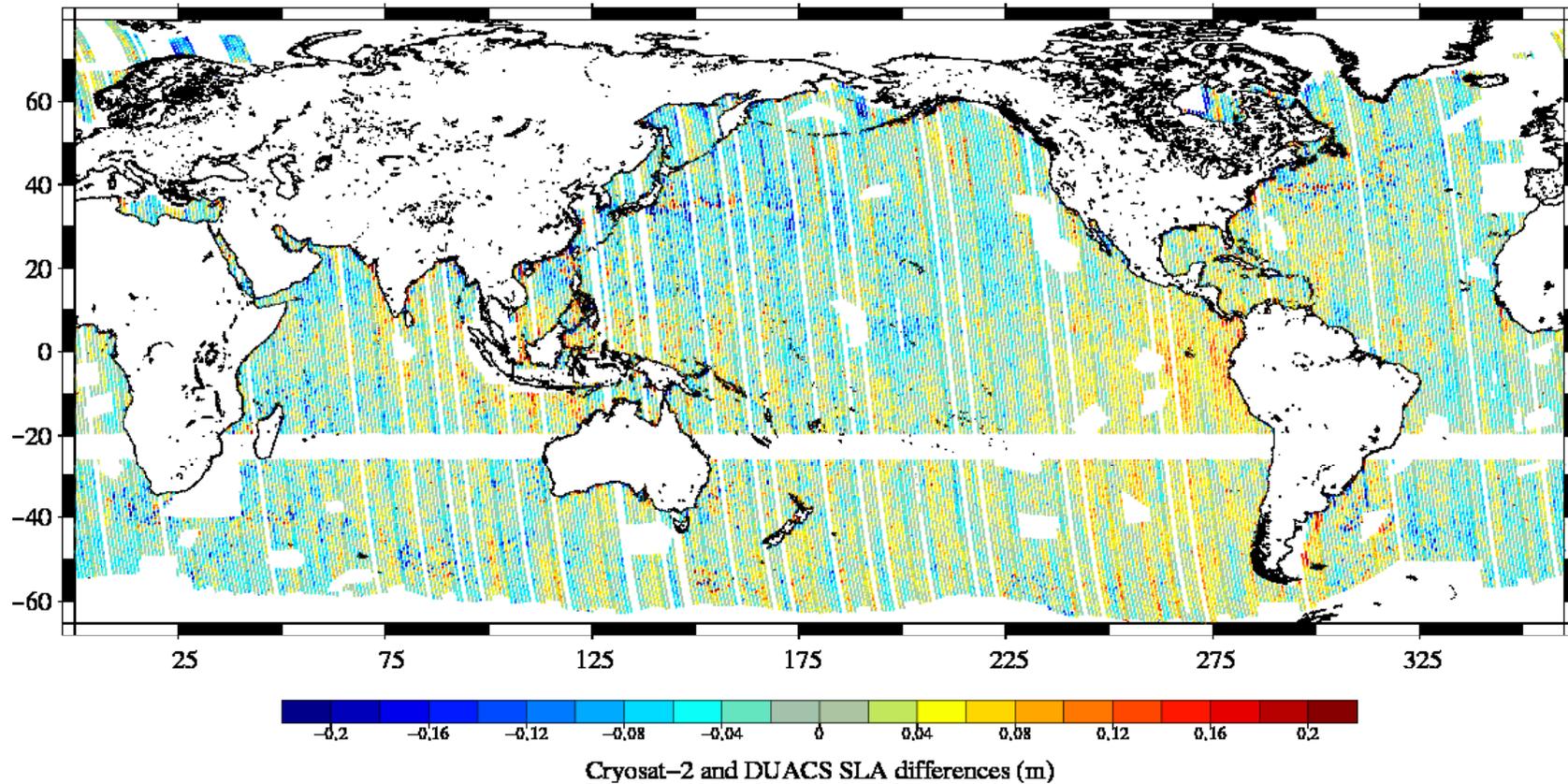


CRYOSAT SLA values from LRM measurements (4)

Results:

CRYOSAT SSHA grids (respect to the MSS) over December, 2010.

Descending passes



CPP Development Progress:

■ CRYOSAT LRM processing chain:

⇒ Development achieved since Sept-2010

⇒ The validation strategy consisted in processing Jason-2 data and to compare CPP Jason-2 products with official Jason-2 products (from SSALTO)

■ CRYOSAT SAR processing chain:

⇒ Development on-going:

- L1 and L1b processing step: achieved
- L2 processing steps: Studies with CLS have been started since mid of 2011 to define a SAR Retracking solution (see next P. Thibaut talk).

⇒ Validation strategy will consist in:

- Generating SAR SLA maps,
- Comparing LRMlooklike and SAR SLA values
- Comparing CPP SAR retracker with other solutions: SAMOSA, others?