Toward an improved estimation of errors in L3/L4 DUACS/AVISO Sea Level products

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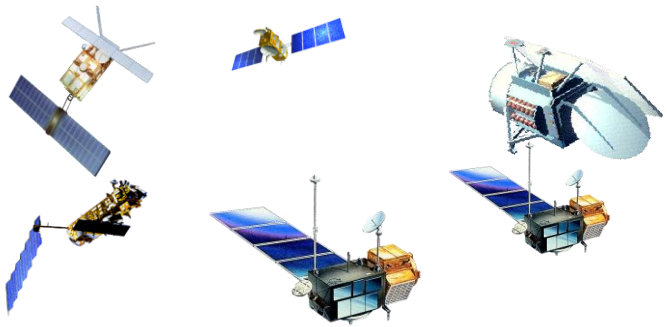
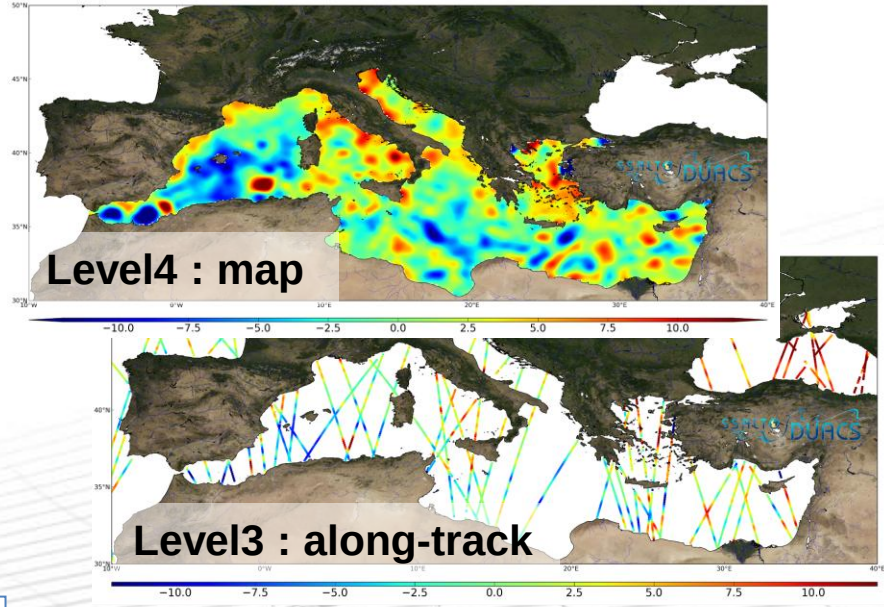
Different product Levels

Level 3&4 products can be directly used for different oceanography applications



Level 2 from space agencies

Non homogeneous

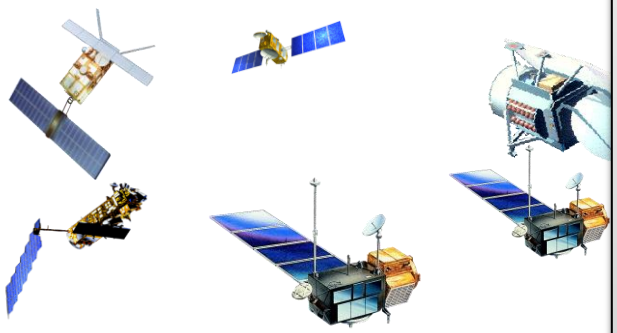


Level 3 & 4 Oceanography product

Homogeneous and error reduced empiricaly (HF, …)

Different product Levels

Level 3&4 products can be directly used for different oceanography applications



Level 2 from space agencies

Non homogeneous

Efforts are done to describe the Level 2 produts errors.

Ex: Jason2 error budget on L2 product (Philipps et al, OSTST 2012

	Error budget	Specifications OGDR	Specifications IGDR	Specifications GDR	Error (<10 days) OGDR	Error (<10 days) IGDR	Error (<10 days) GDR	GOAL
Parameters and corrections for raw sea surface height calculation	Altimeter range	>1.7 cm[a,b,c]			>1.6 - 1.7 cm			1.5 cm[a,b,c]
	Ionosphere	1 cm[a,c]	0.5 cm[d,c]		>1 cm[h] / >0.2 cm[i]			0.5 cm[d,c]
	Sea State Bias	3.5 cm	2 cm		>0.4 cm			1 cm
	Dry troposphere	1 cm	0.7 cm		0.4-0.7 cm	0.3-0.7 cm		0.7 cm
	Wet troposphere	1.2 cm			>0.2 cm			1 cm
	Rms Orbit (radial component)	10 cm	2.5 cm	1.5 cm	>3.7 cm	>1.7 cm	>1.0 cm	1.5 cm
Altimeter parameters	Significant wave height	10% or 50 cm[f]	10% or 50 cm[f]		13 cm			5% or 25 cm[f]
	Wind speed	1.6 m/s	1.5 m/s		1 m/s			1.5 m/s
	Sigma0 (absolute)	0.7 dB			0.11 dB			0.5 dB
Raw sea surface height		11 cm[A]	3.9 cm[A]	3.4 cm[A]	> 4.2 cm[A]/-	> 2.6 cm[A] - 2.8 cm[B]	>2.1 cm[A] - 2.4 cm[B]	2.5 cm[A]
Final sea surface height		?	?	?	< 5.0 cm[C]	< 4.1 cm[C]	< 4.0 cm[C]	

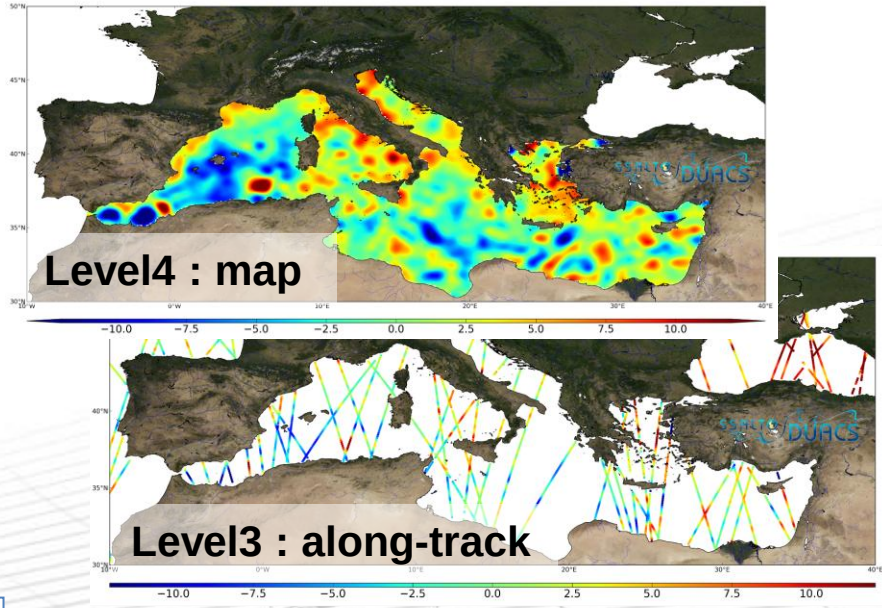
a Ku-band after ground retracking
b Averaged over 1 sec
c Assuming 320 MHz C-bandwidth
d filtered over 100 km
e real time doris onboard ephemeris
f whichever is greater
h non filtered value
i filtered over 300 km

A Computed with , Assuming that errors in the table are uncorrelated (which is not the case).
B from formation flight phase (jason-1/ Jason-2)
C from cross-over computations of jason-2 data

Level 3&4 products can be directly used for different oceanography applications

Few information about the errors associated to the L3/L4 products are available whereas it is an important input for different applications (ex: data assimilation)

➔We give a first estimate based on different diagnostics

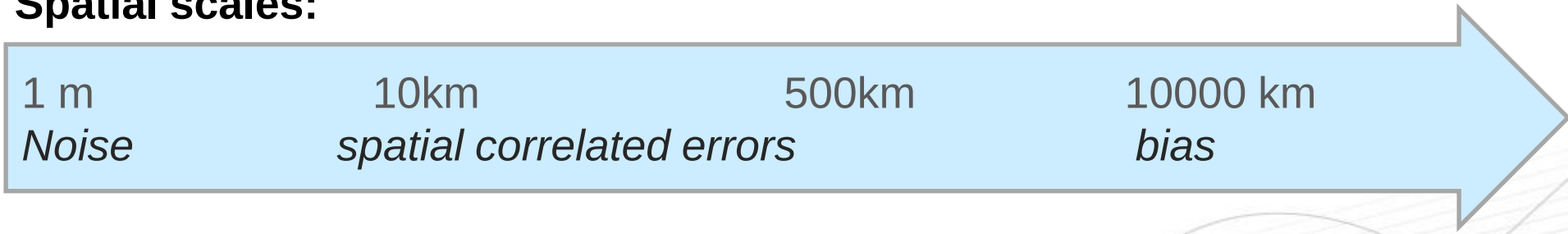


Level 3 & 4
Oceanography product
Homogeneous and error reduced empiricaly (HF, …)

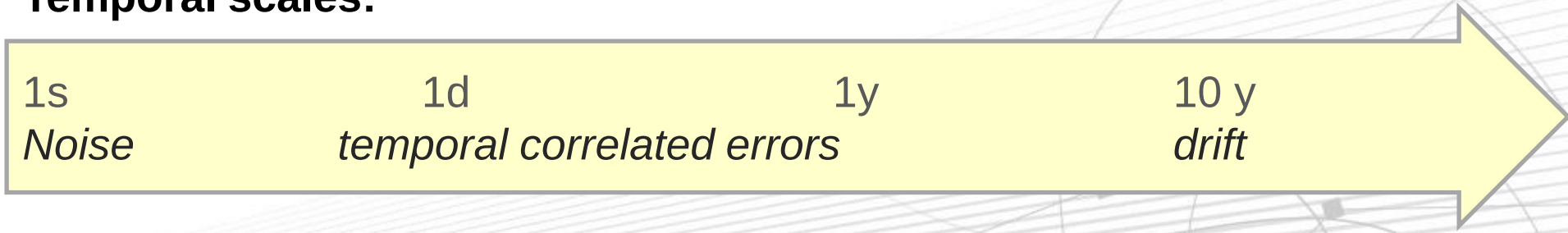
Different kinds of errors

Errors can be described for different spatial/temporal scales

Spatial scales:



Temporal scales:



Level 3 along-track products:

- 10-day signal error estimation

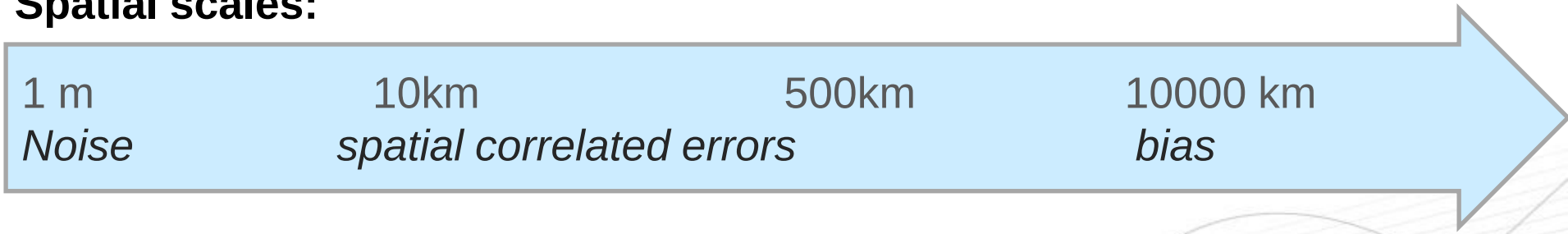
Level 4 maps products:

- mesoscale errors estimation

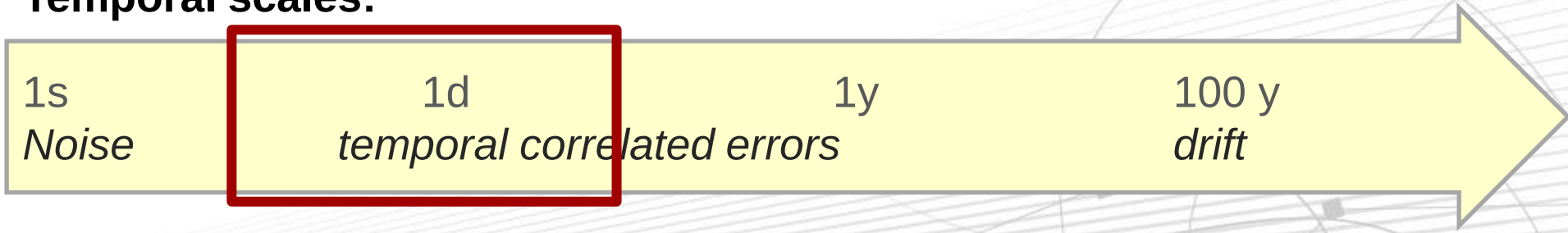
Description of the errors observed with the DUACS DT 2014 products

L3 errors estimation

Spatial scales:



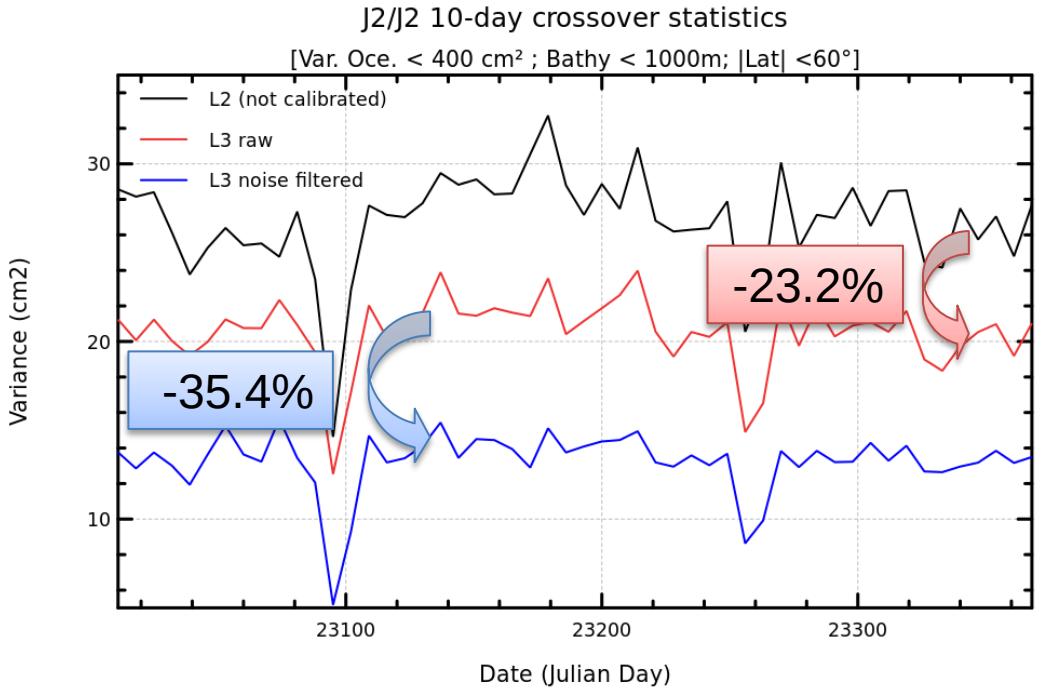
Temporal scales:



L3 1Hz errors estimation

- High frequency signal : 10-day crossover statistics [2013], DUACS 2014 products

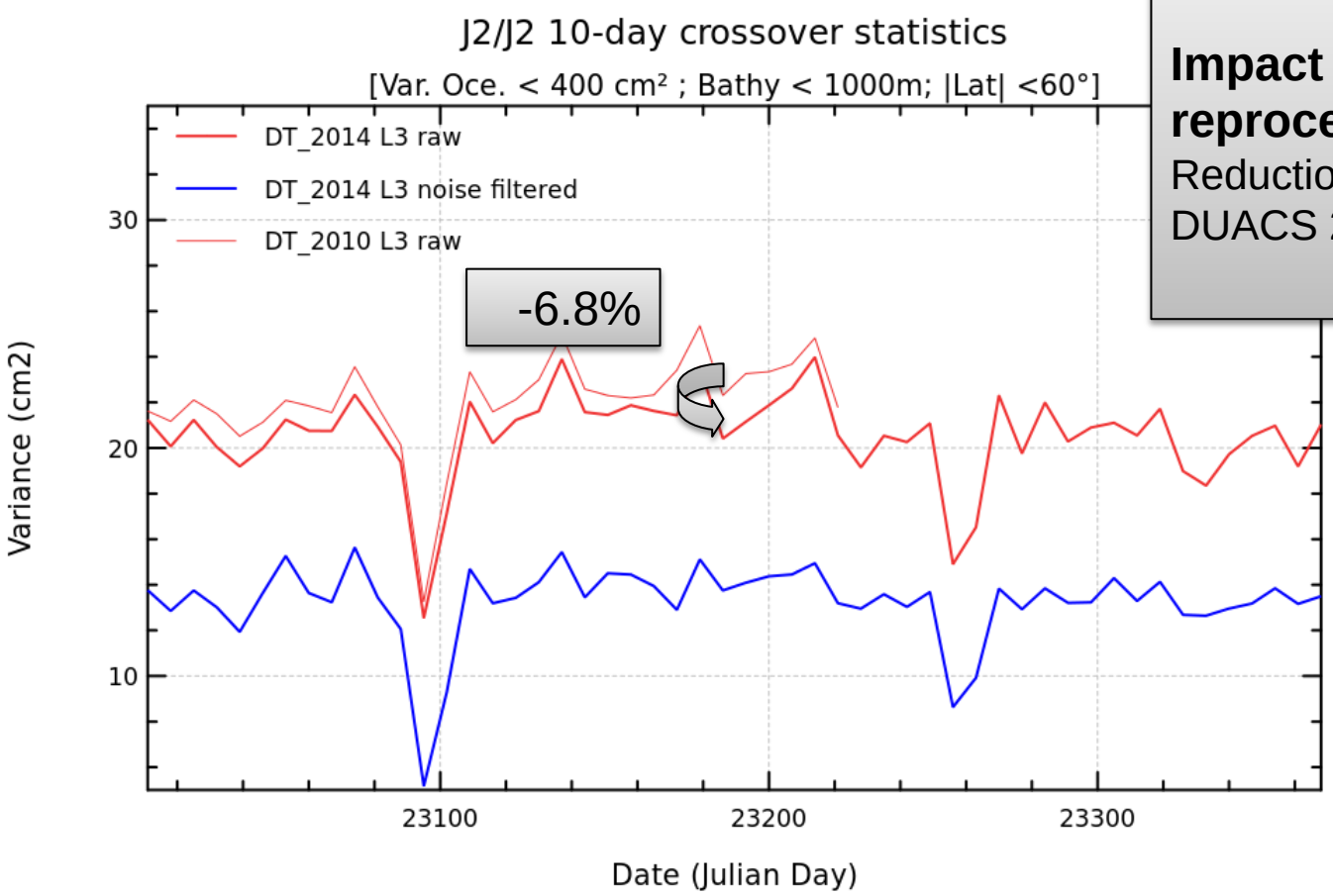
Along-track error deduced from X statistics (cm)	J2	AL	C2
Level 2 (no EO reduction)	3.7	-	-
Raw Level 3	3.2	2.9	3.0
65km filtered Level 3	2.6	2.6	2.5



- Contains also residual 10-day ocean variability
- Does not take into account the correlated error
- Link with crossover properties different from an altimeter to the other

L3 1Hz errors estimation

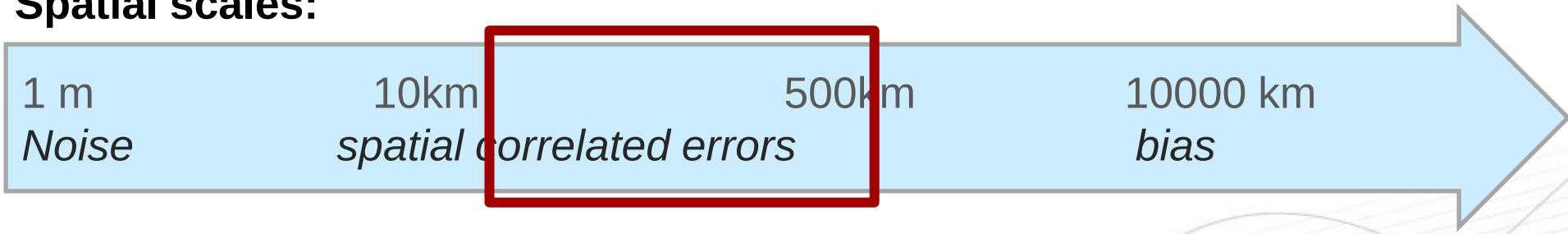
- High frequency signal : 10-day crossover statistics [2013]



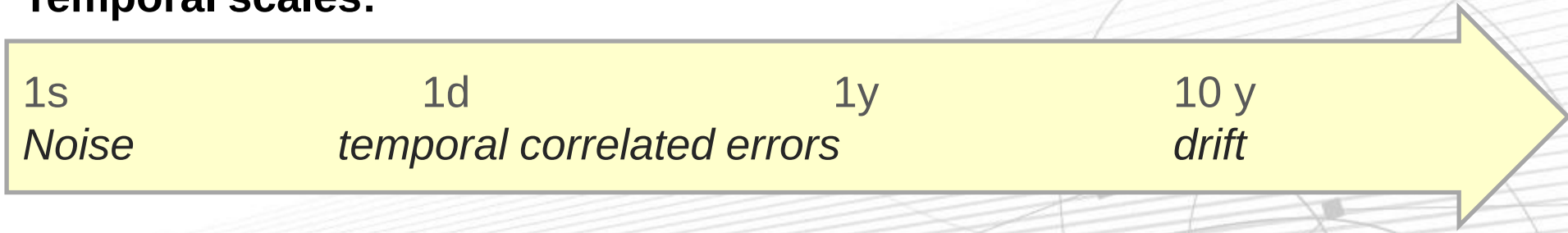
Impact of the DUACS 2014 reprocessing:
Reduction of the Level 3 errors vs DUACS 2010 version

L4 errors estimation

Spatial scales:



Temporal scales:



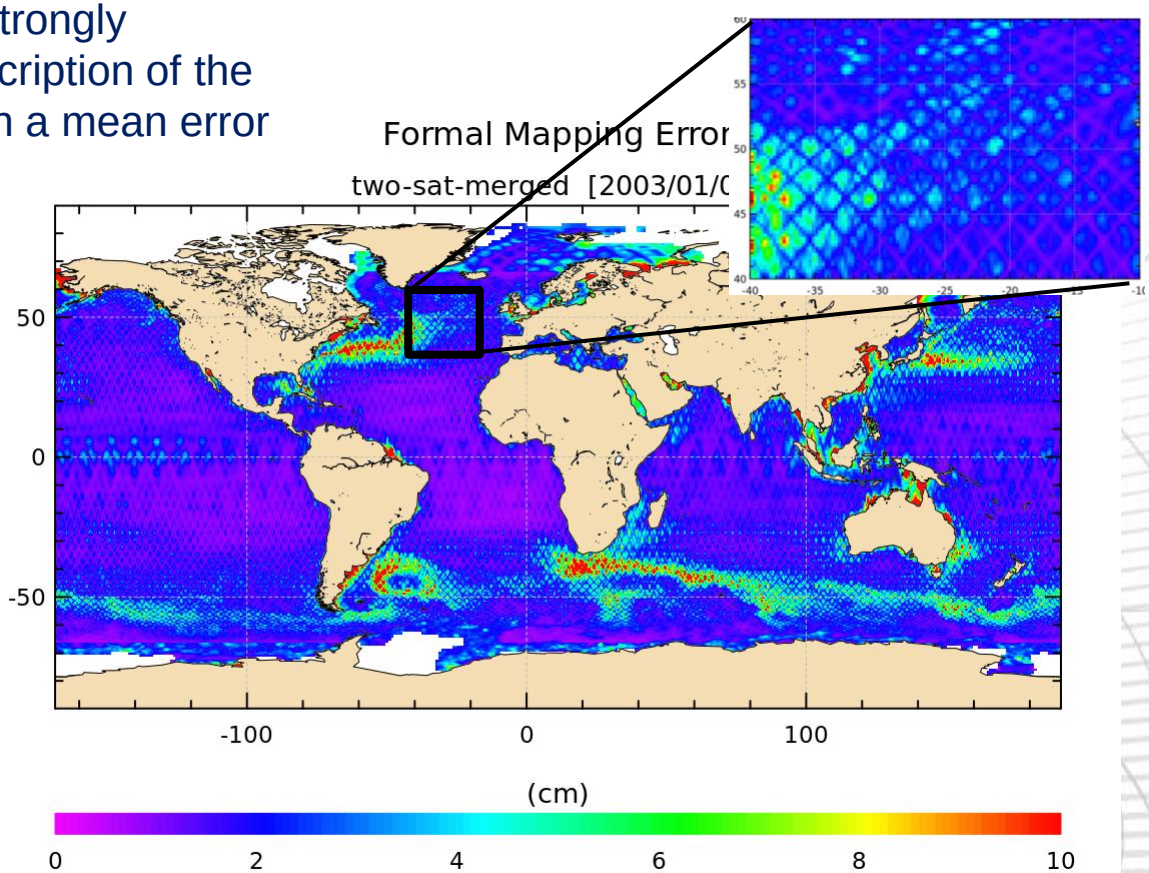
L4 errors estimation

- **Historical :** formal mapping error (Bretherton et al. 1976)

– Formal error adjustment : mainly correlated to the spatial sampling vs surface variability, correlation scales & altimeter errors prescribed.

→ Gives an indication of the accuracy of a map in a given time/space location, but strongly depends on the quality of the description of the covariance matrix. (here based on a mean error estimation of the input data)

$$e^2 = C_{xx} - \sum_{i=1}^{m} \sum_{j=1}^{m} C_{xi} C_{xj} A^{-1}_{ij}$$



Higher error in
- high variability areas
- Altimeter tracks diamonds

L4 errors estimation

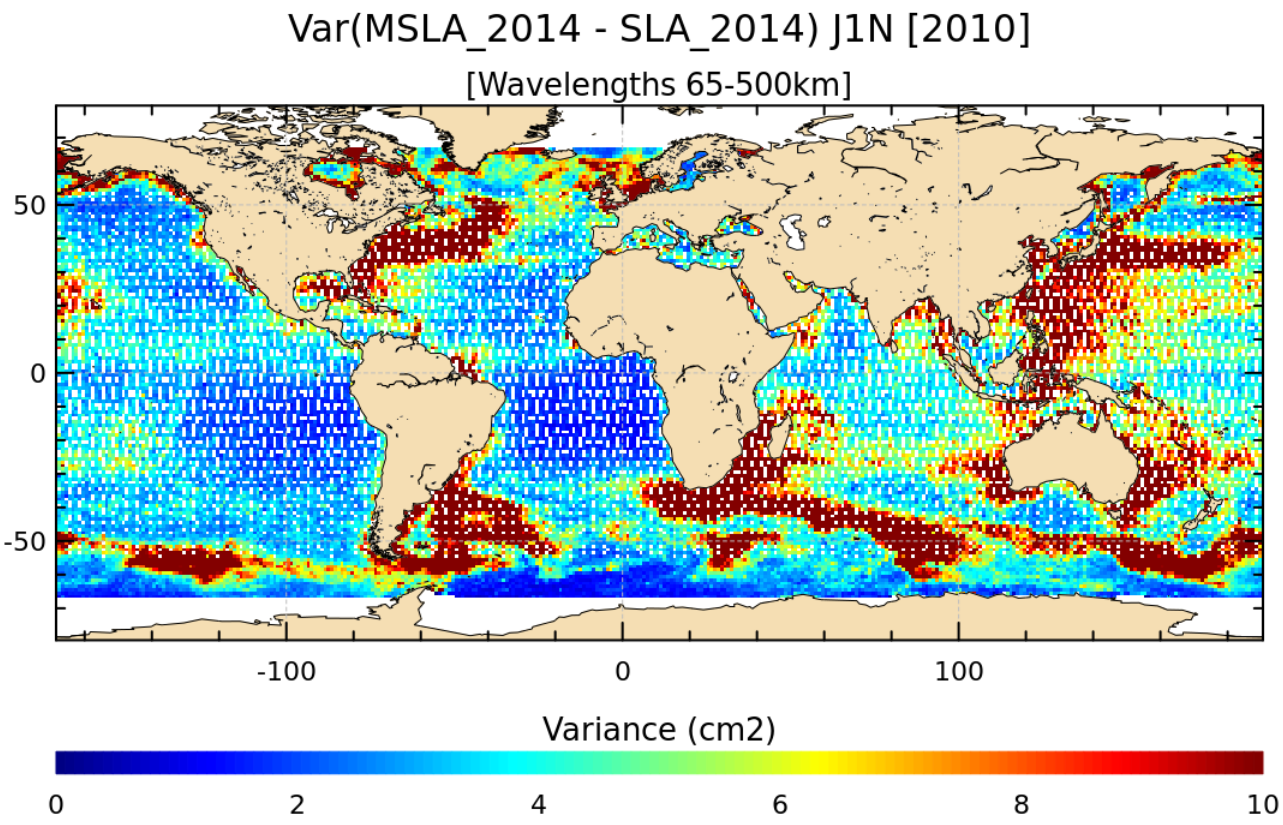
“two-sat-merged” maps are compared with along-track products not used in the mapping.

- Analysis of the variance of the differences for wavelengths ranging 500-65 km

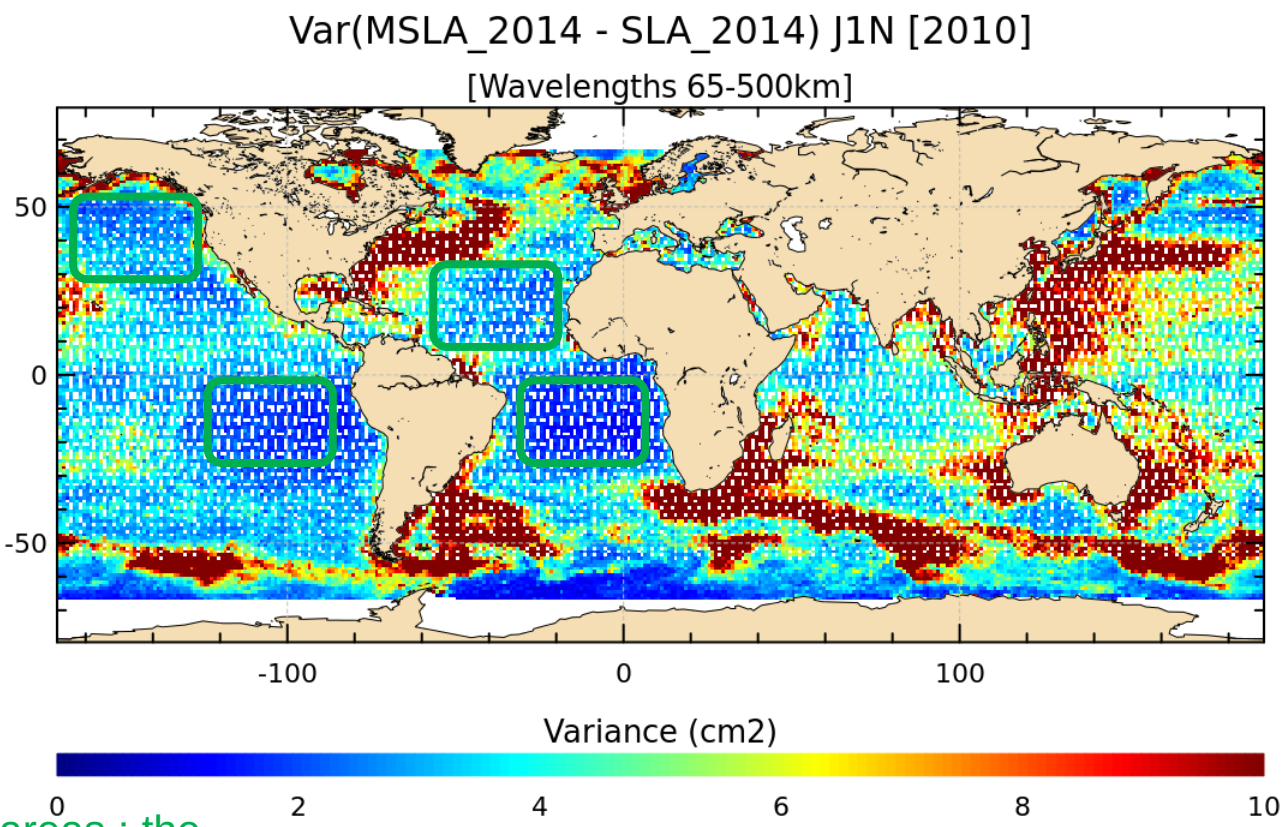
➔ Definition of the L4 mean errors for mesoscale signals:

- Assume error mainly on map products : smoothed and missing signal
- Does not take into account the correlated errors (strong assumption ! since altimeter standards are quite uniform for the different altimeters)

L4 errors estimation



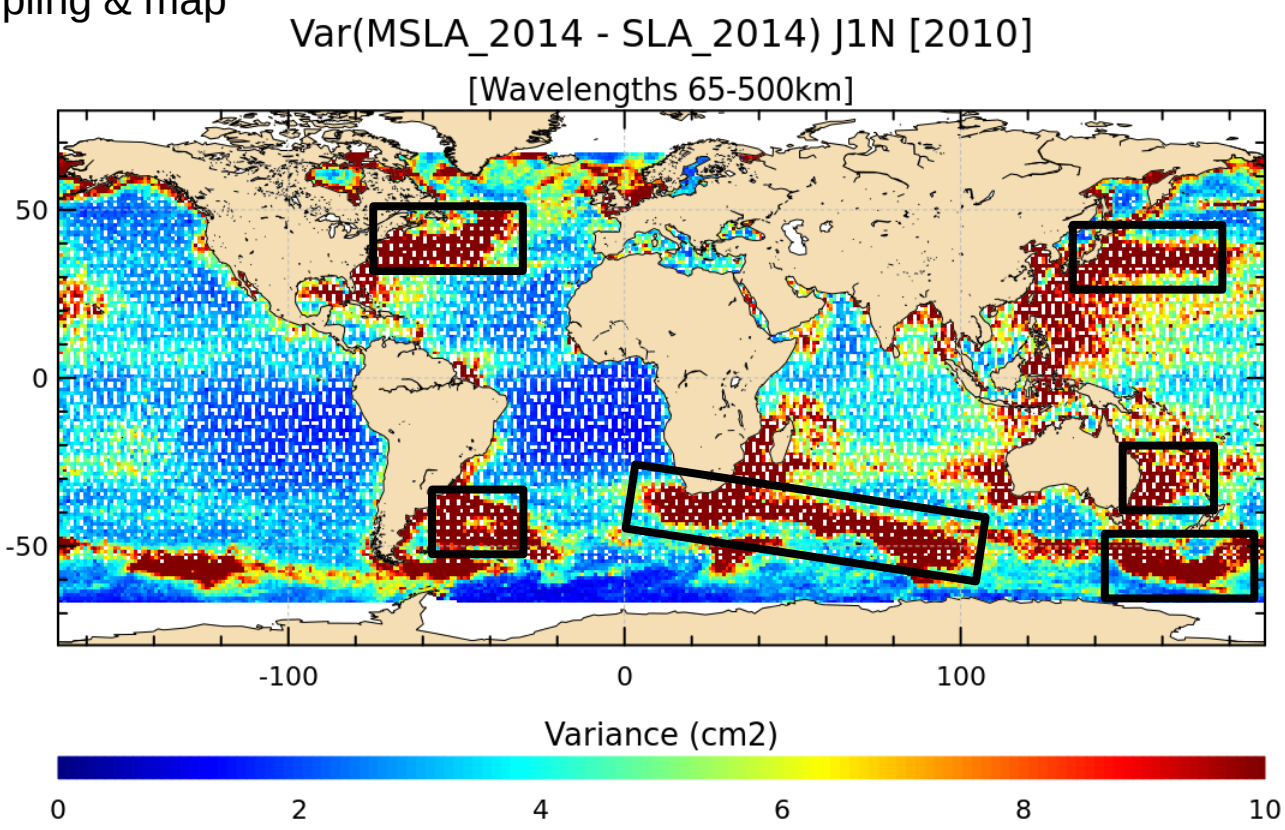
L4 errors estimation



Low variability areas : the mesoscale signal is quite well sampled and mapped

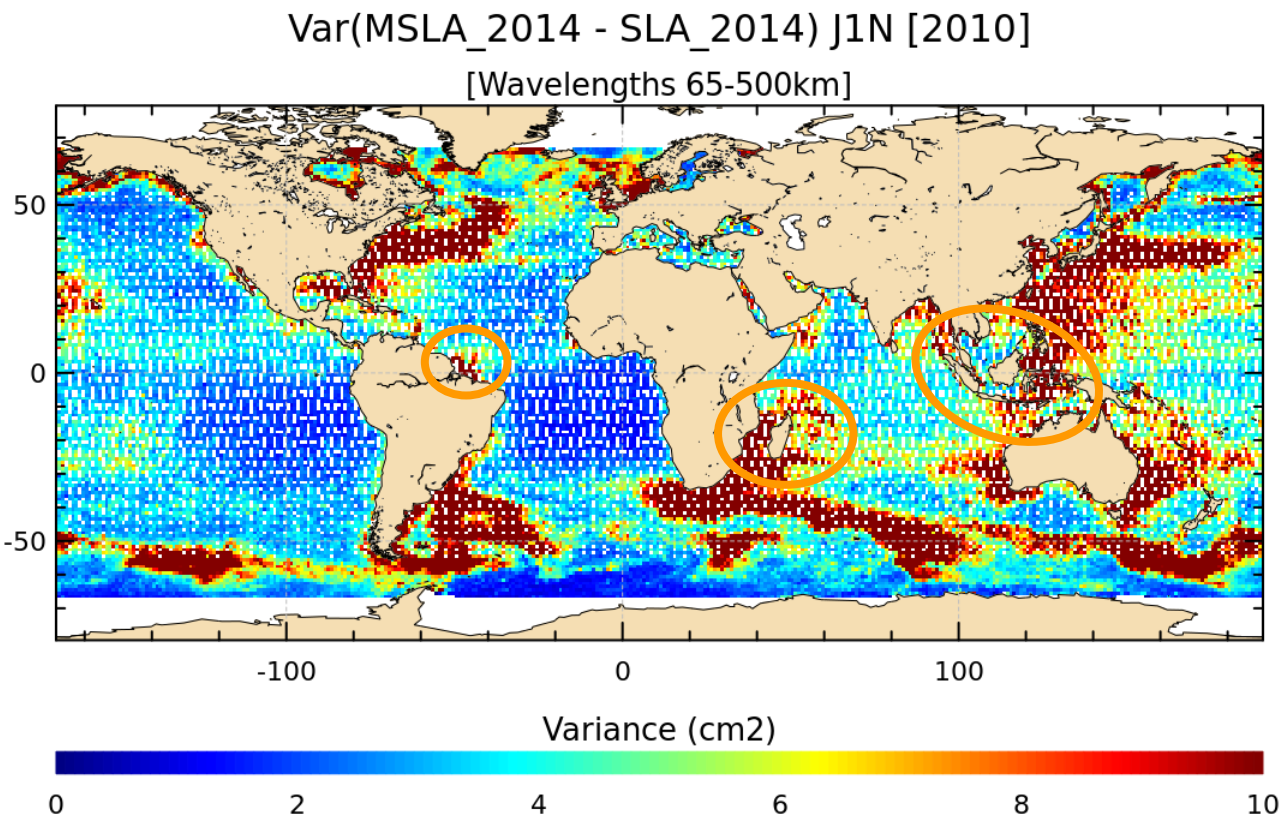
L4 errors estimation

High variability areas : part of the mesoscale signal is missing in the map product (altimeter sampling & map smoothing)



L4 errors estimation

Coastal areas : Higher errors linked with geophysical corrections quality (tides, internal waves)

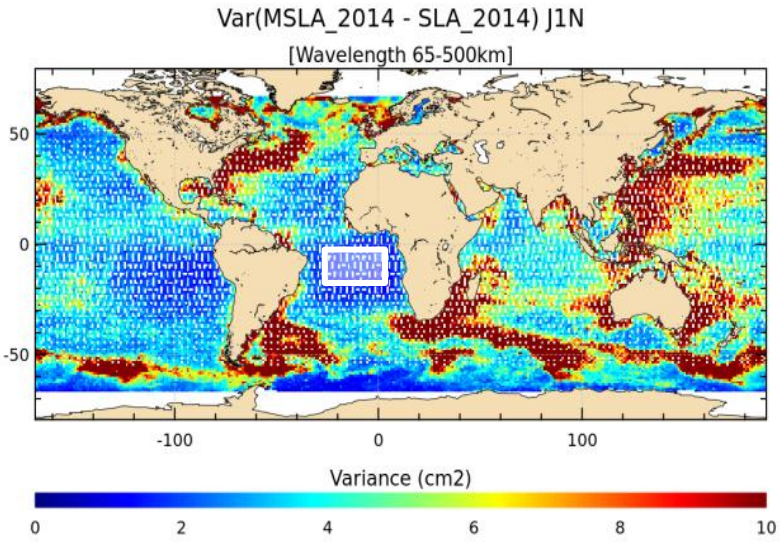


L4 errors estimation

Var(MSLA-SLA) [λ=65-500km] (cm^2)	TPN	J1N
Reference area	1.4	1.6
D>200km ; Var < 200 cm^2	4.9	5.1
D>200km ; Var > 200 cm^2	32.5	30.8
D<200km	8.9	9.7

"two-sat-merged" maps are compared with along-track products not used in the mapping.

Reference area = very low variability area
- Minimal error on map products = 1.2 cm



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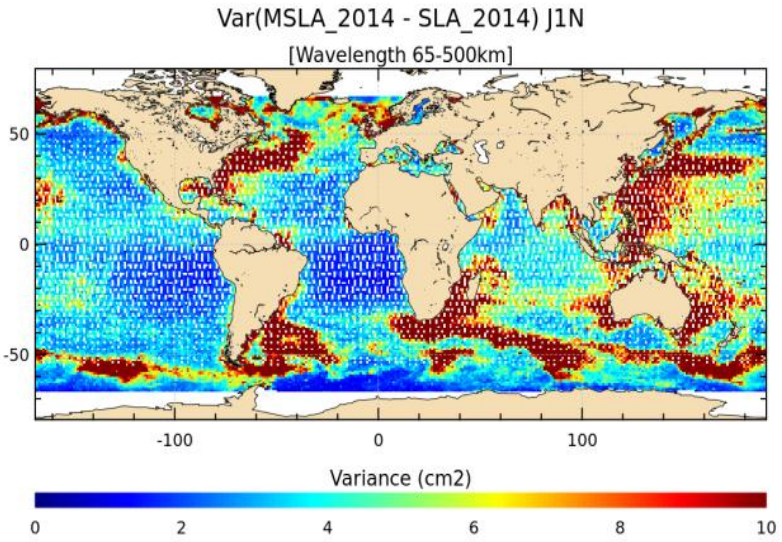
"two-sat-merged" maps are compared with along-track products not used in the mapping.

Low variability areas :
- Mean error = 2.2 cm

High variability areas :
- Mean error = 5.6 cm

Coastal areas :
- Mean error = 3 cm
- higher in western boundary regions



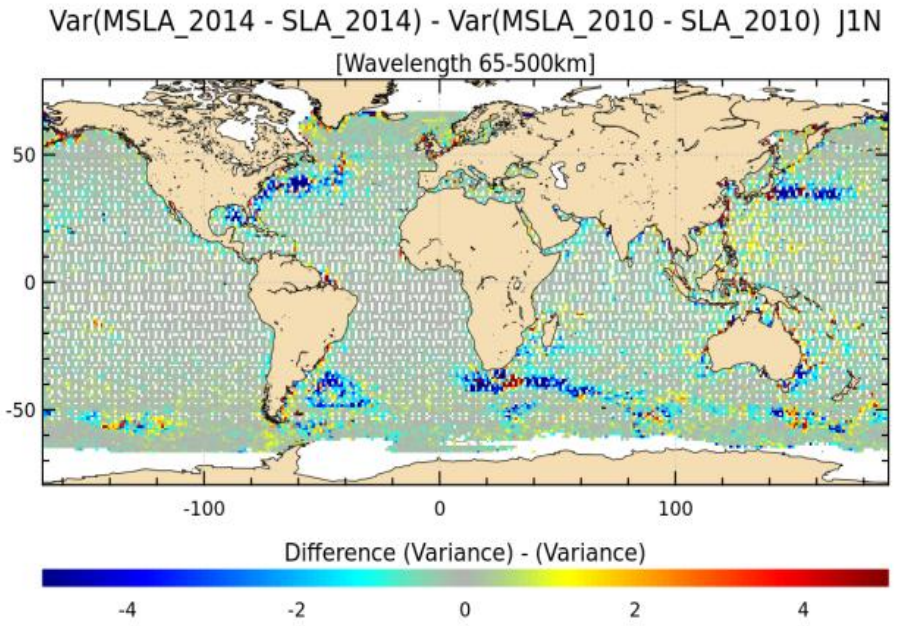
L4 errors estimation

Var(MSLA-SLA) reduction [λ=65-500km] (%)	TPN	J1N
D>200km ; Var < 200 cm²	-2.1%	-1.9%
D>200km ; Var > 200 cm²	-9.9%	-5.0%
D<200km	-4.1%	+2.8%

Impact of the DUACS 2014 reprocessing:
Reduction of the Level 4 errors vs DUACS 2010 version

Low variability areas :
- Mean error reduction = 2 %

High variability areas :
- Mean error reduction = 5 to 10%



Conclusions & ongoing work

- We are improving the **L3** (along-track) error description:
  - Improved quantification of the high frequency (< 10 days) errors :
    - 2.5cm on 65km low-pass filtered along-track
    - Error reduced by more than 50% between L2 and filtered L3.

- We are improving the **L4** (maps) error description:
  - Use independent altimeter measurements for quantification of the errors at mesoscale:
    - errors ranging 2.2 (low variability) to 5.6 cm (high variability areas)
  - Quantification of the error reduction with previous products (DT2014 vs DT2010):
    - Reduction ranging 2% (low variability) to 5-10% (high variability areas)

Conclusions & ongoing work

- We need to go further:
  - L3: toward an “instantaneous” error including sea state variability (SWH, SSB, …)
  - L4: complete the diagnostics with independent measurements (ie. in situ)
  - L3/L4: take into account other kind of errors (i.e. larger spatial/temporal scale)

Thank you for your attention