Effect of the processing methodology on satellite altimetry-based global mean sea level rise over the Jason-1 operating period

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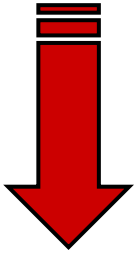
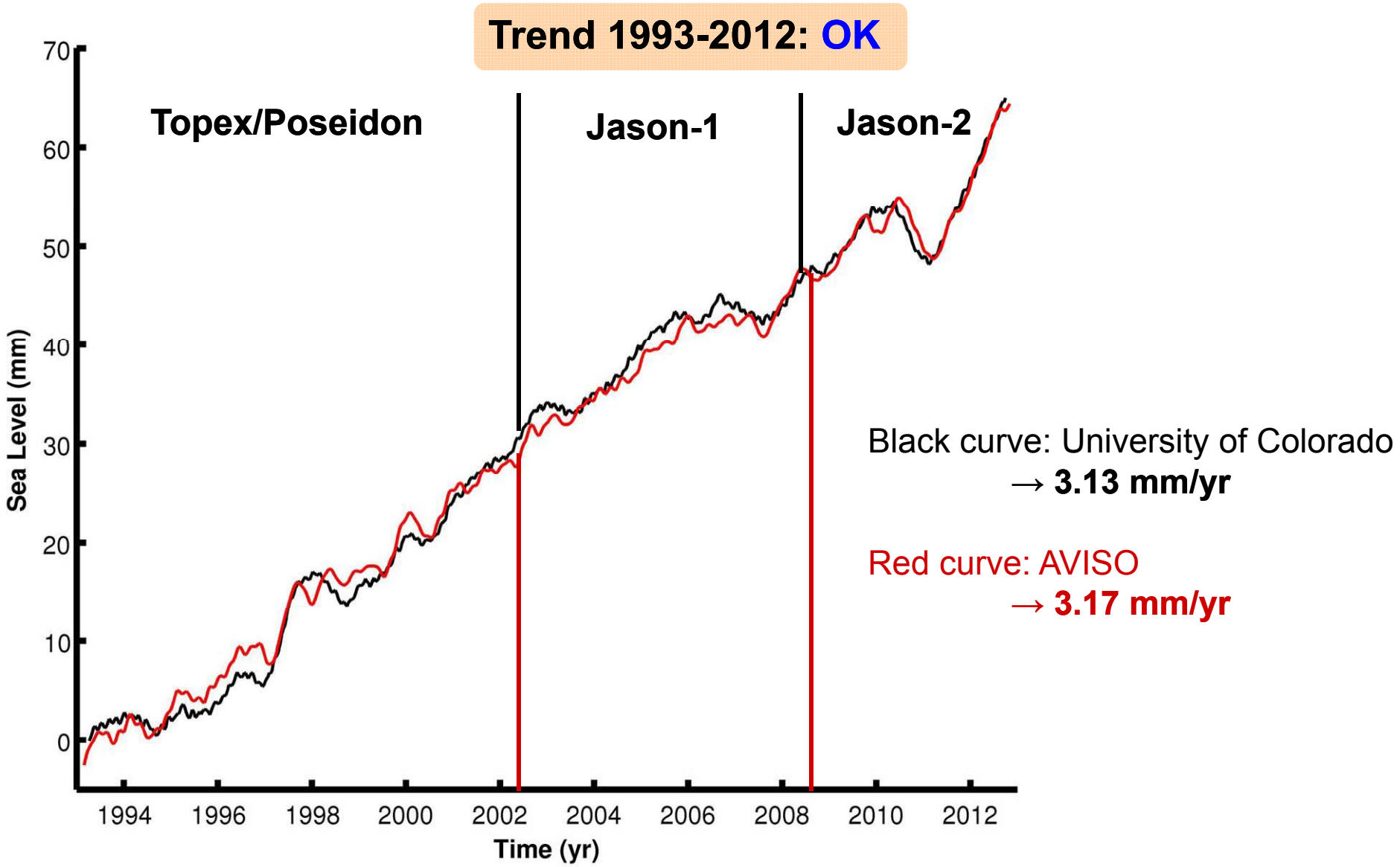
Main satellite altimetry processing groups

- University of Colorado (CU)
- NASA/GSFC
- NOAA
- CSIRO
- AVISO



Differences in **trend** and **interannual variability** reported in the **altimetry-based sea level time series** processed by these groups

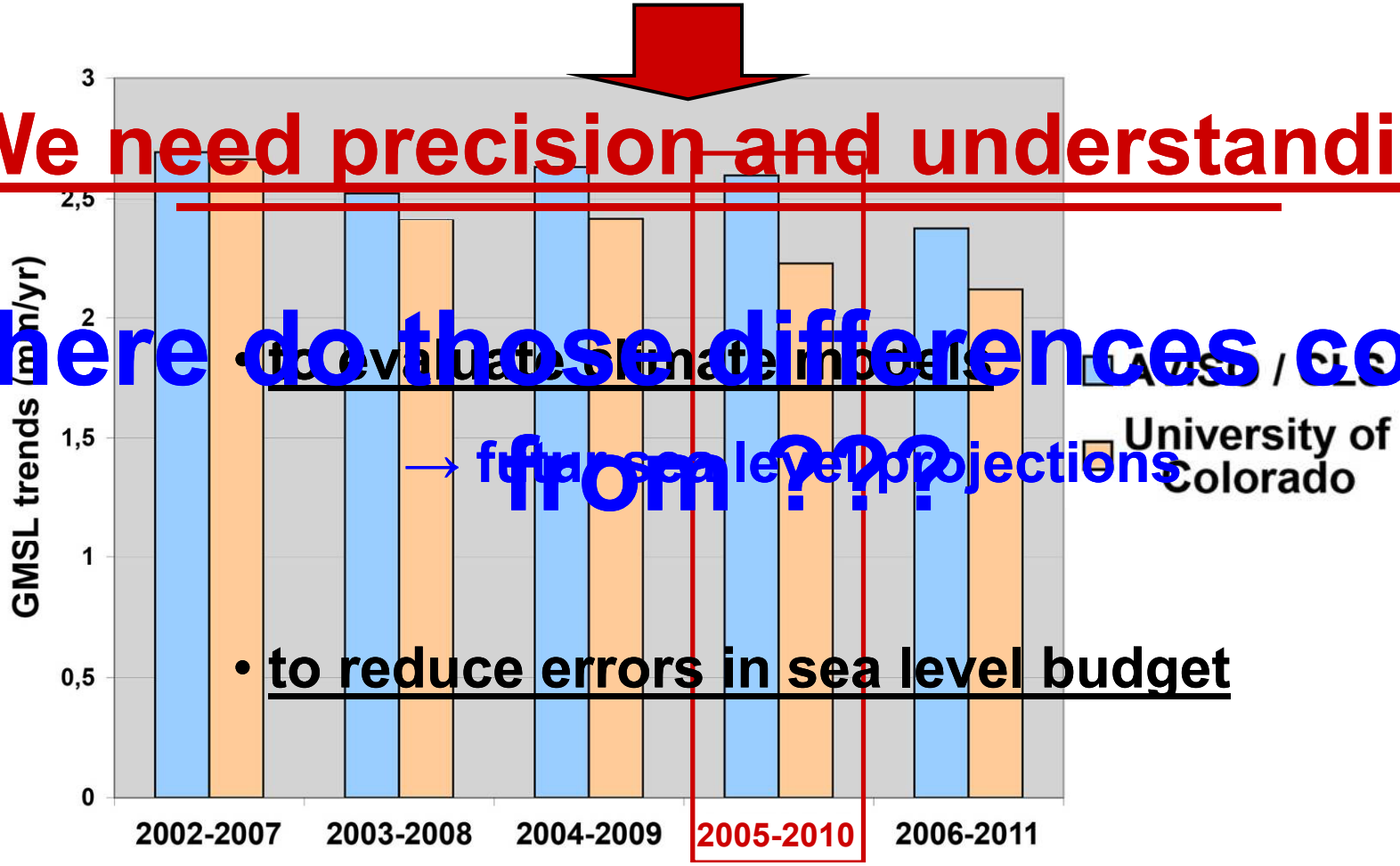
Altimetry-based Global Mean Sea Level (GMSL)



6 yr GMSL trends from AVISO and University of Colorado

1993 – 2012 → observed sea levels trends: OK

Observed sea levels trends on short time span: PROBLEM !!



We need precision and understanding

Where do those differences come from ???

- **to evaluate climate models**

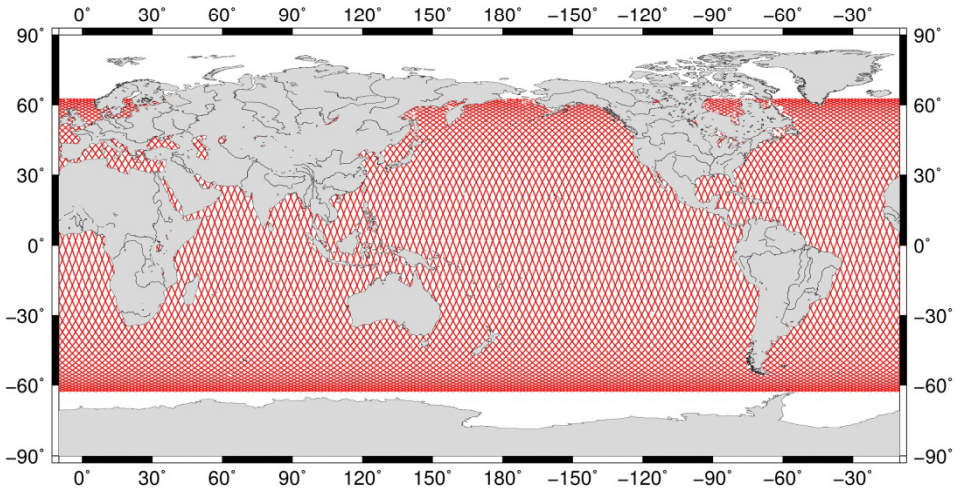
  → future sea level projections

- **to reduce errors in sea level budget**

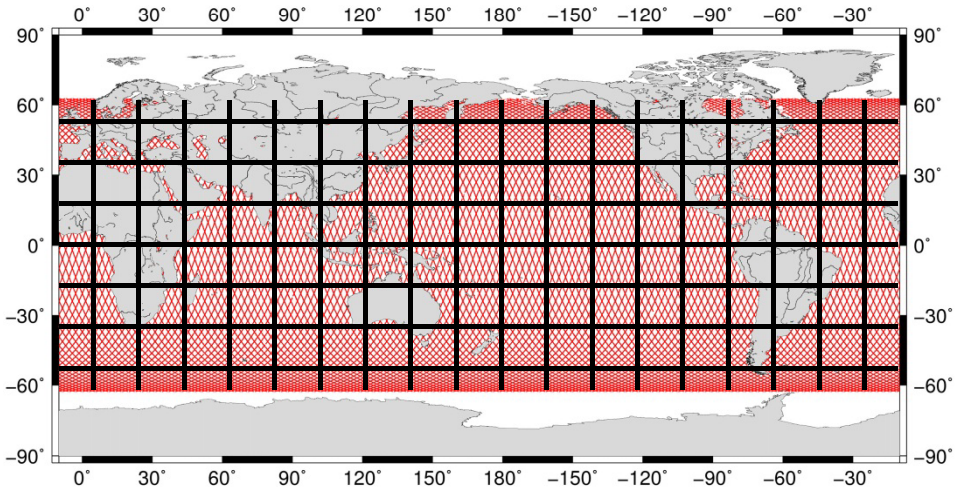
Masters et al., *Marine Geodesy*, 2012

2 main sources of differences:

- Geophysical corrections
- Averaging methods



Averaging along-track data
(CU method)



Data gridding (2°x2°) before averaging
(AVISO method)

Objectives of the present study

1. Investigate the effects of processing methodology to compute the GMSL:

→ ***along-track*** *versus* ***gridded*** *SSH anomalies*

→ *minimum ocean depth*

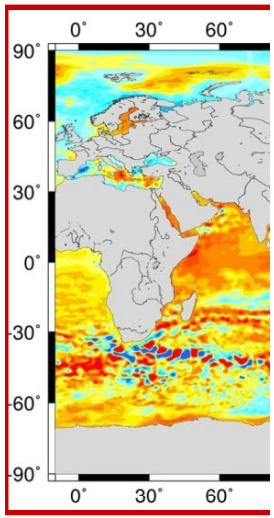
→ *altimetry data validity flag*

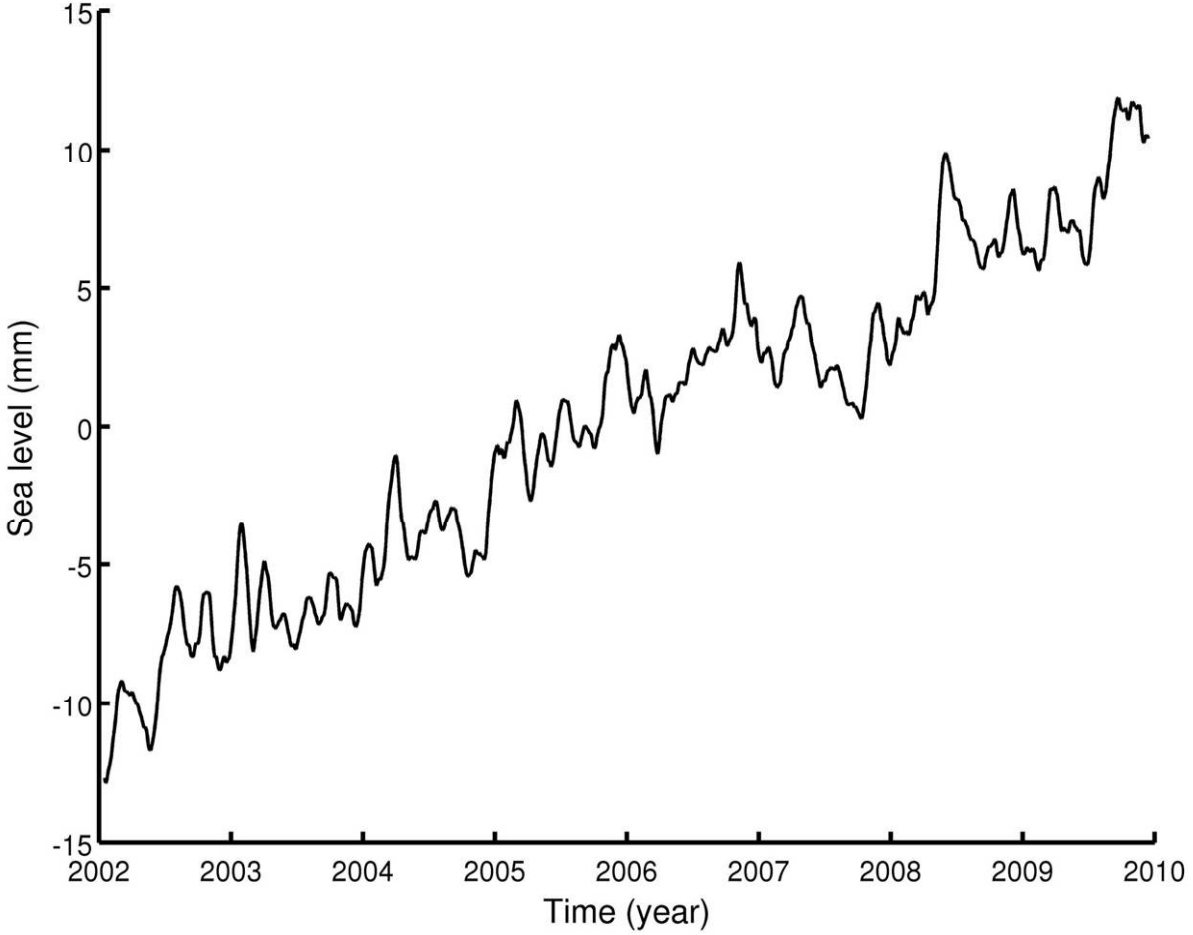
2. Generate synthetic altimetry data during the Jason-1 operating period using **MERCATOR OGCM**

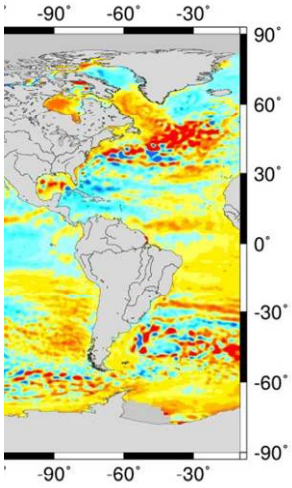
3. Perform a series of test calculations of the GMSL time series

MERCATOR OGCM

- Version GLORYS2V1 with data assimilation (temperature, salinity, …).
- Horiz
- Resc







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Series of tests performed using different criteria

1. Raw averaging methods:

→ along track averaging (as CU)
→ simple gridding (2°x2° as AVISO)
→ global averaging
→ latitude band averaging

2. Data gridding:

→ 1°x1°, 2°x2° (as AVISO), 3°x3°
→ gridding with inverse distance weighting

3. Minimum ocean depth:

→ 0m (as AVISO), 120m (as CU), 500m

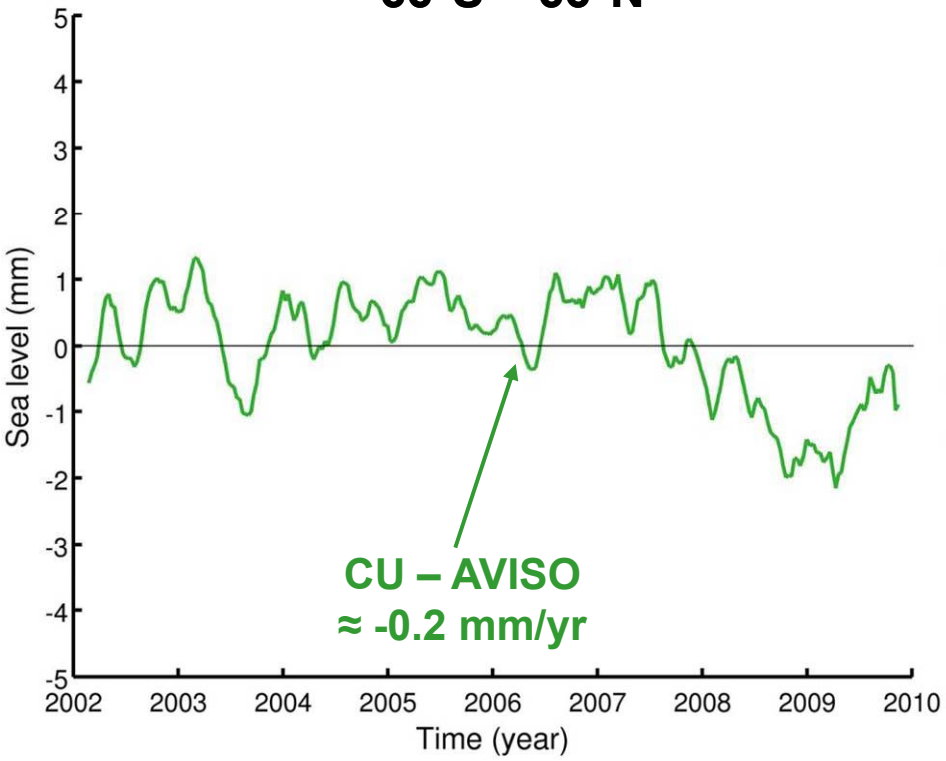
4. Altimetric flag:

→ based on AVISO validity flag

Effect of the averaging method on the GMSL time series

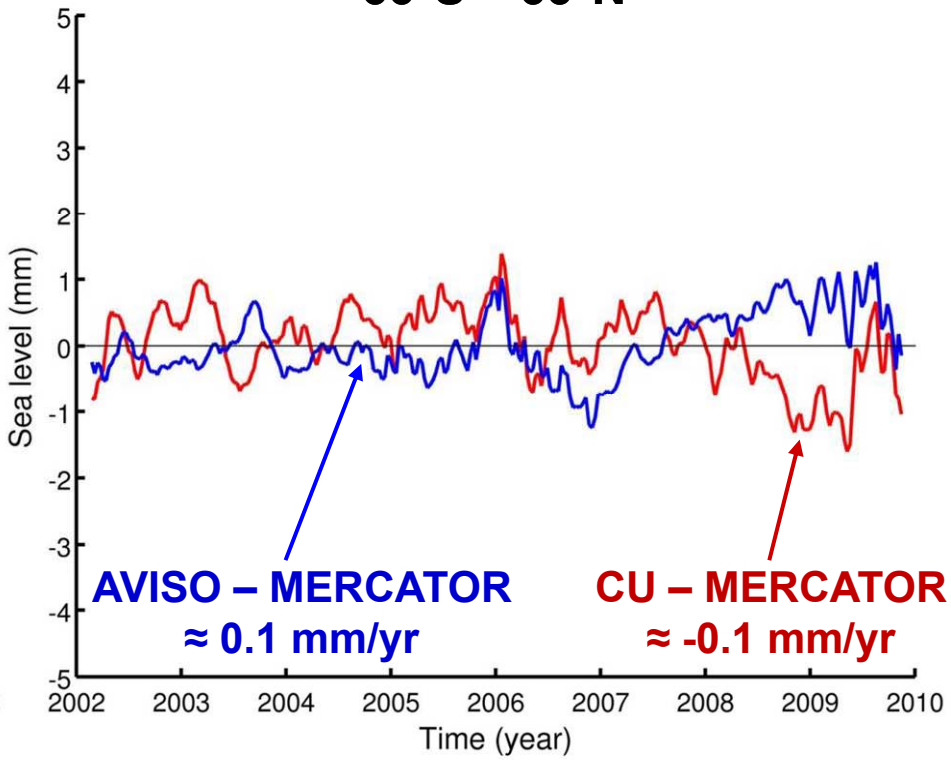
GMSL difference between along-track averaging and gridding methods

66°S – 66°N



GMSL difference between each averaging method and the reference (MERCATOR)

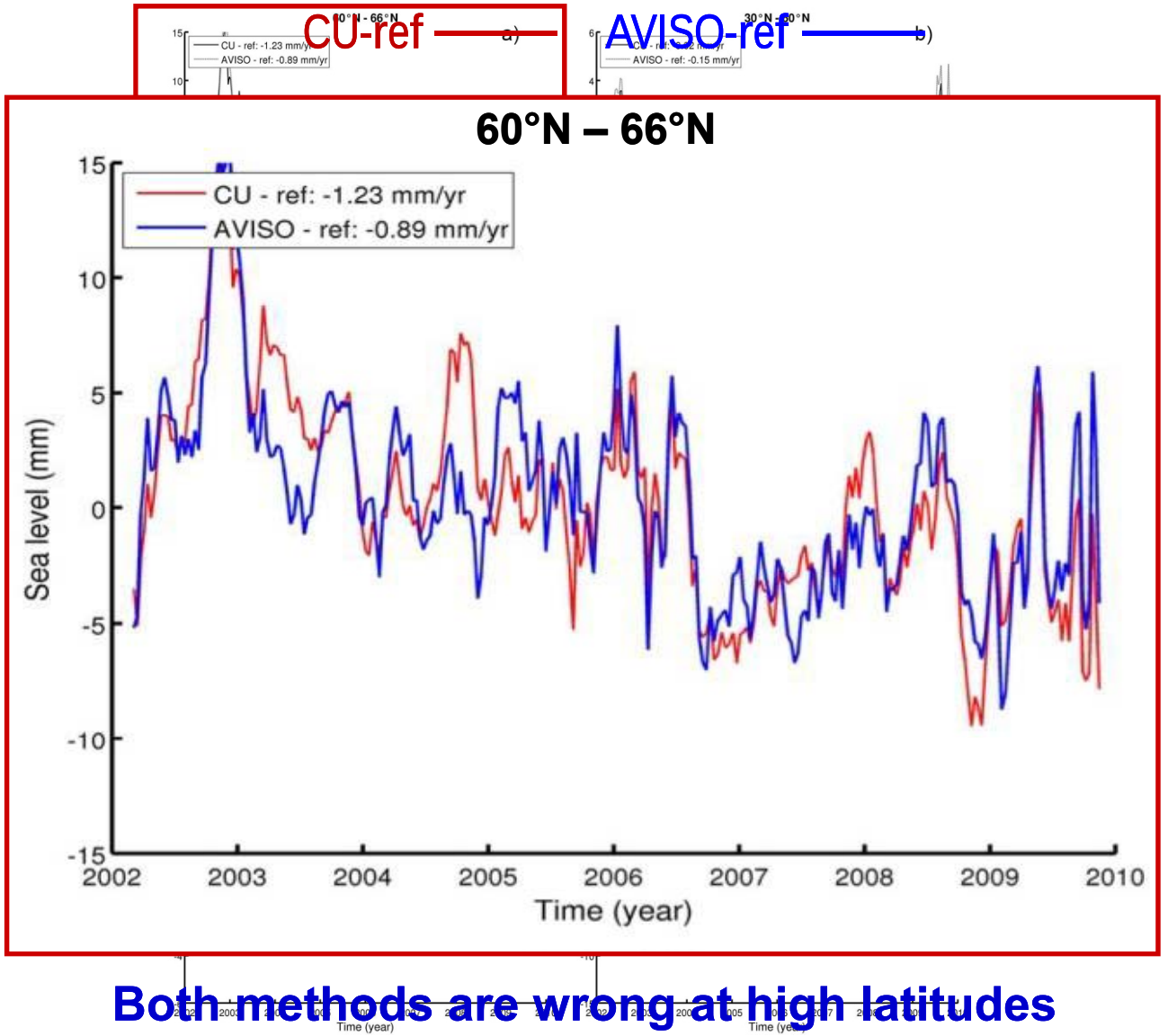
66°S – 66°N



GMSL differences with the reference for different latitude bands

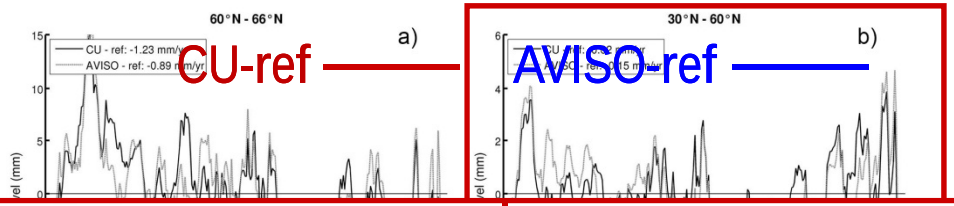
CU-ref

AVISO-ref



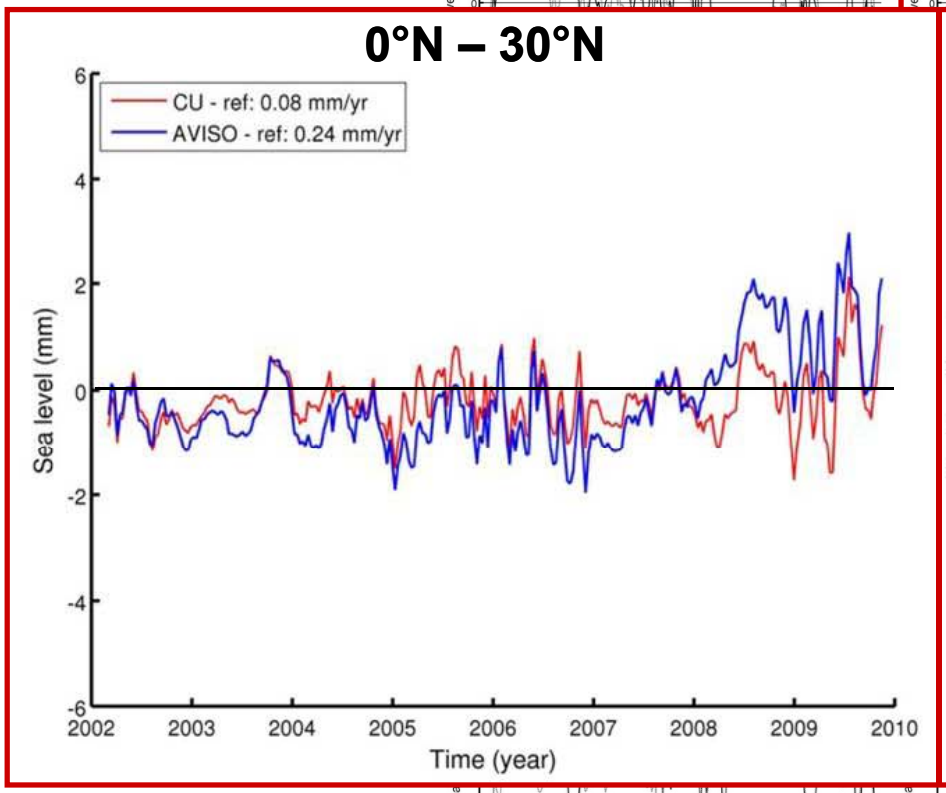
Both methods are wrong at high latitudes

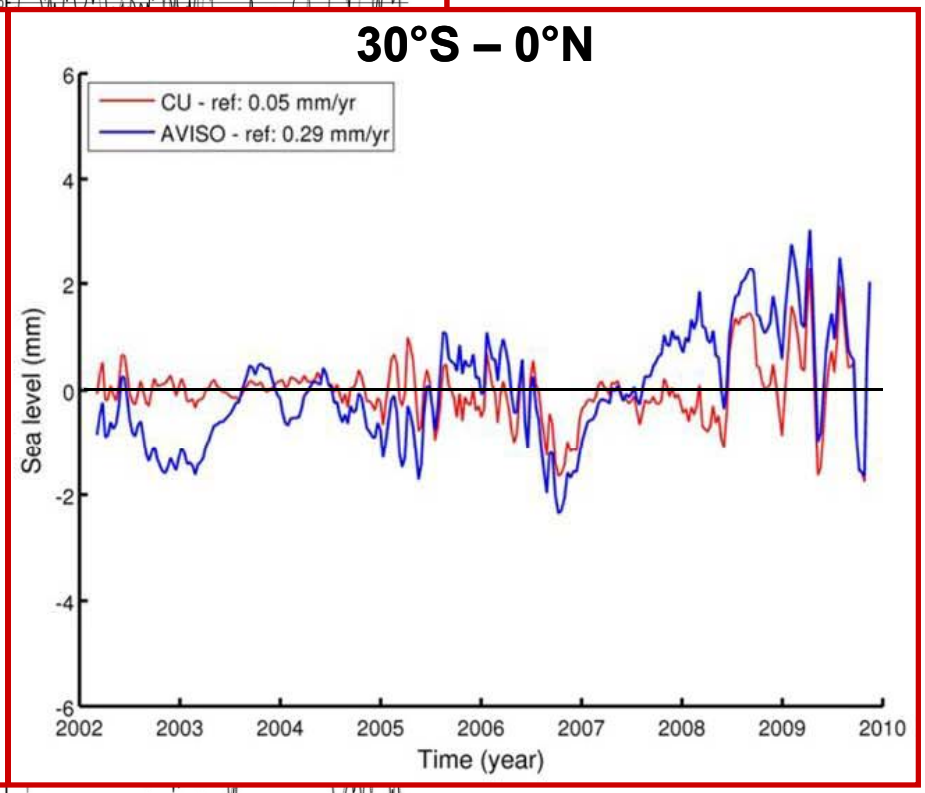
GMSL differences with the reference for different latitude bands



CU-ref

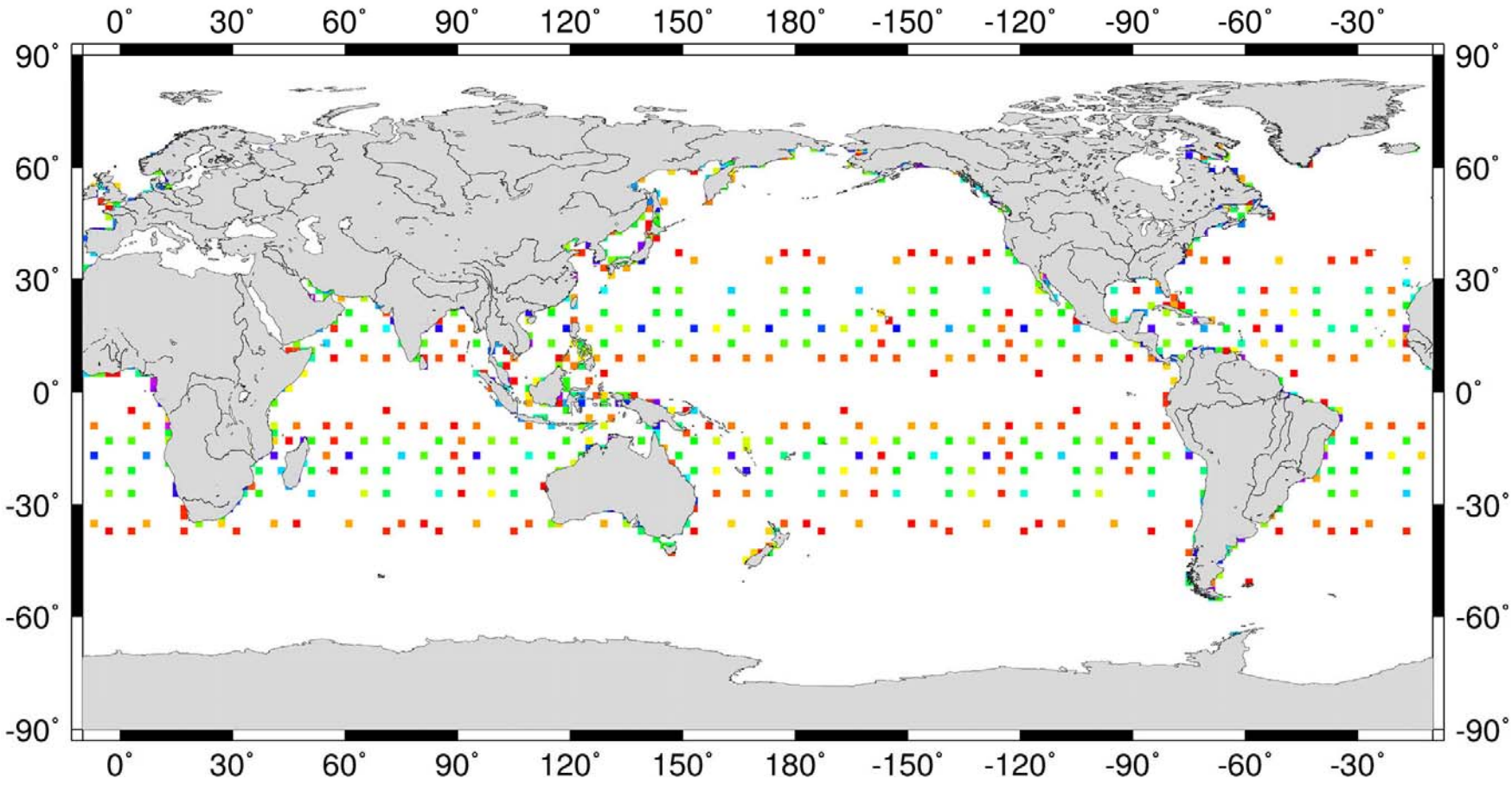
AVISO-ref

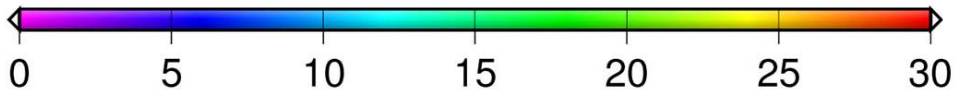




Largest trend differences found for AVISO sea level data in the Tropics

Grid cells used in AVISO gridding process with less than 30 valid data per orbital cycle

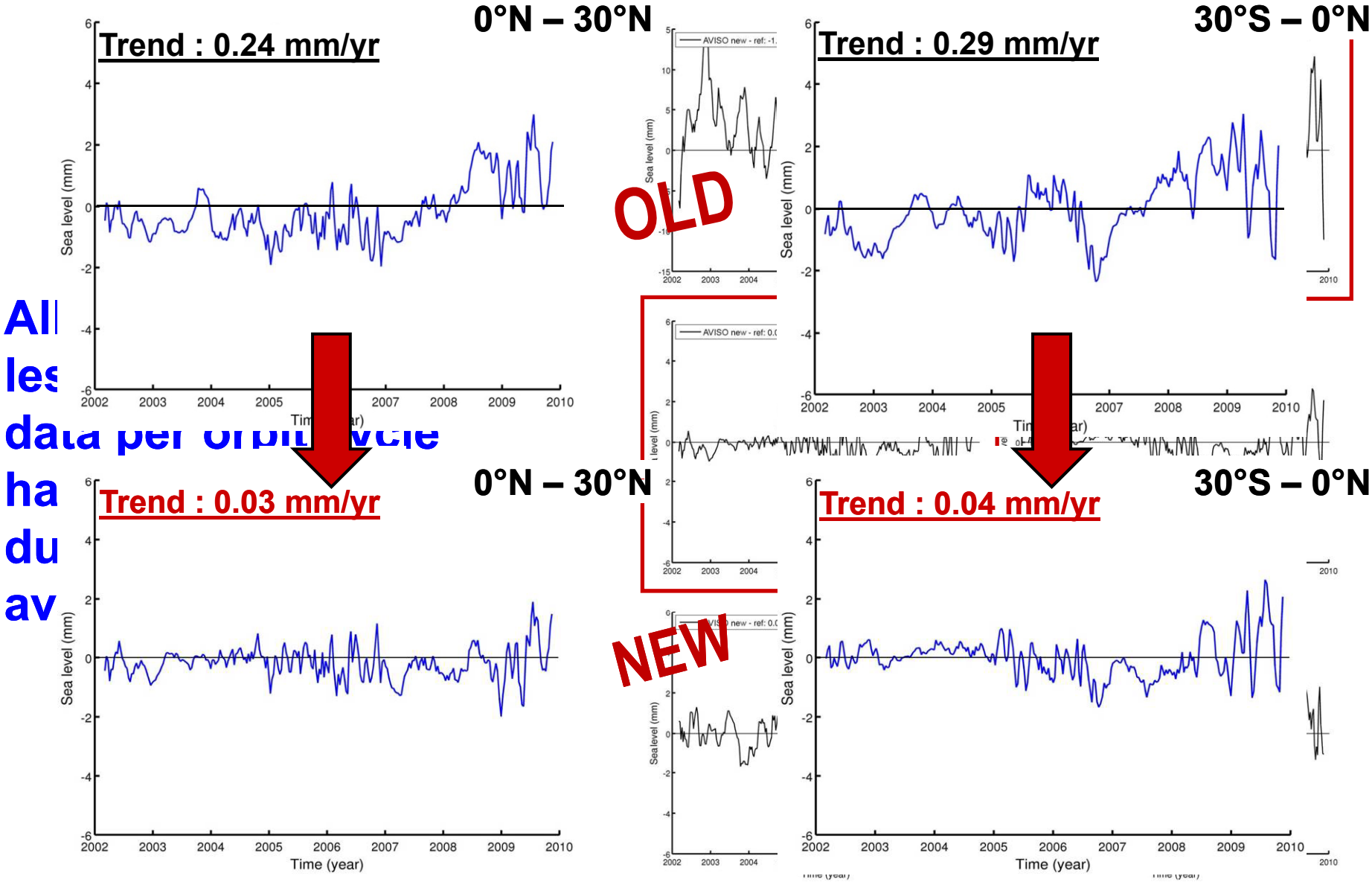




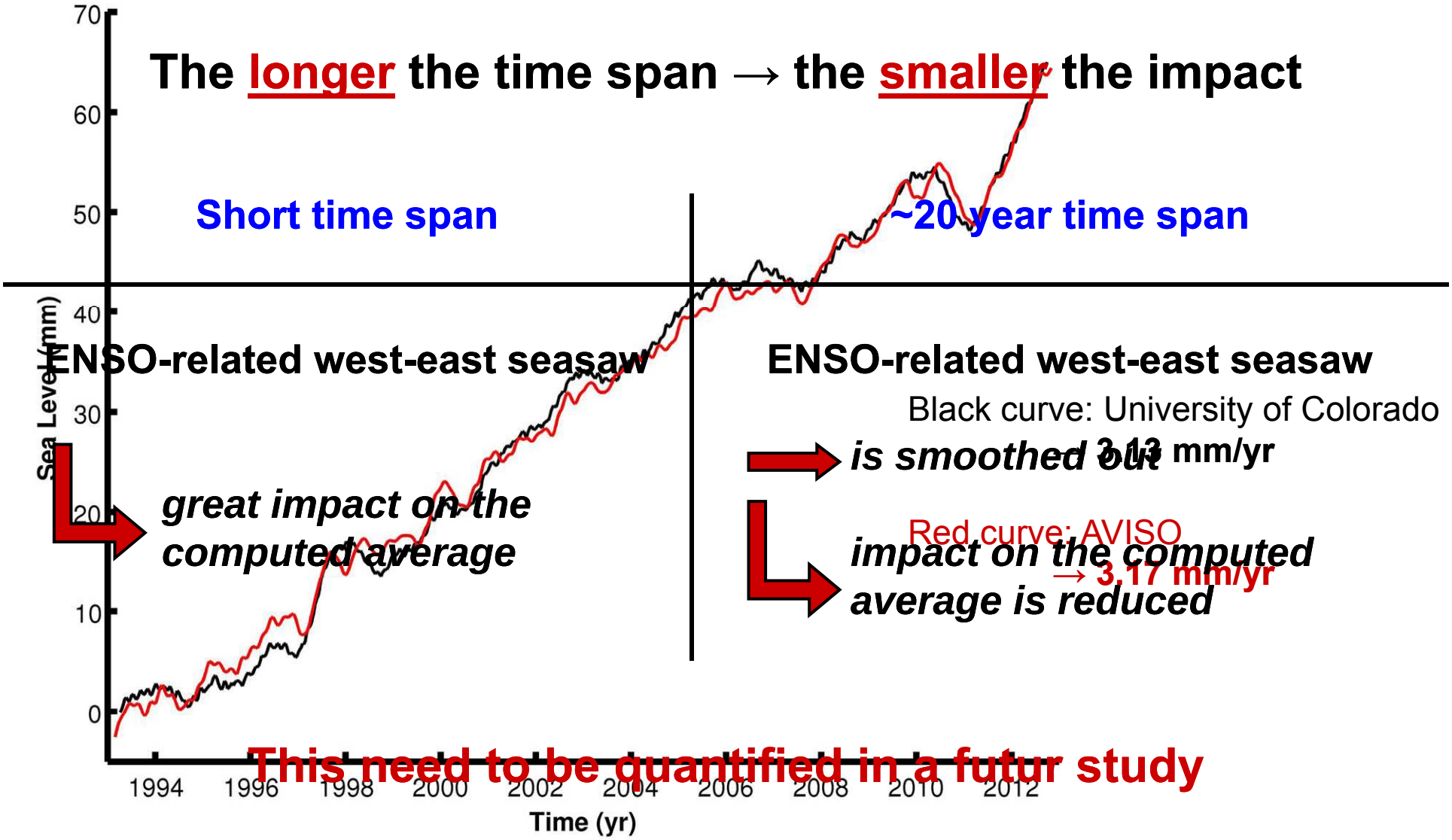
Number of valid sea surface height data

43rd Jason-1 orbital cycle

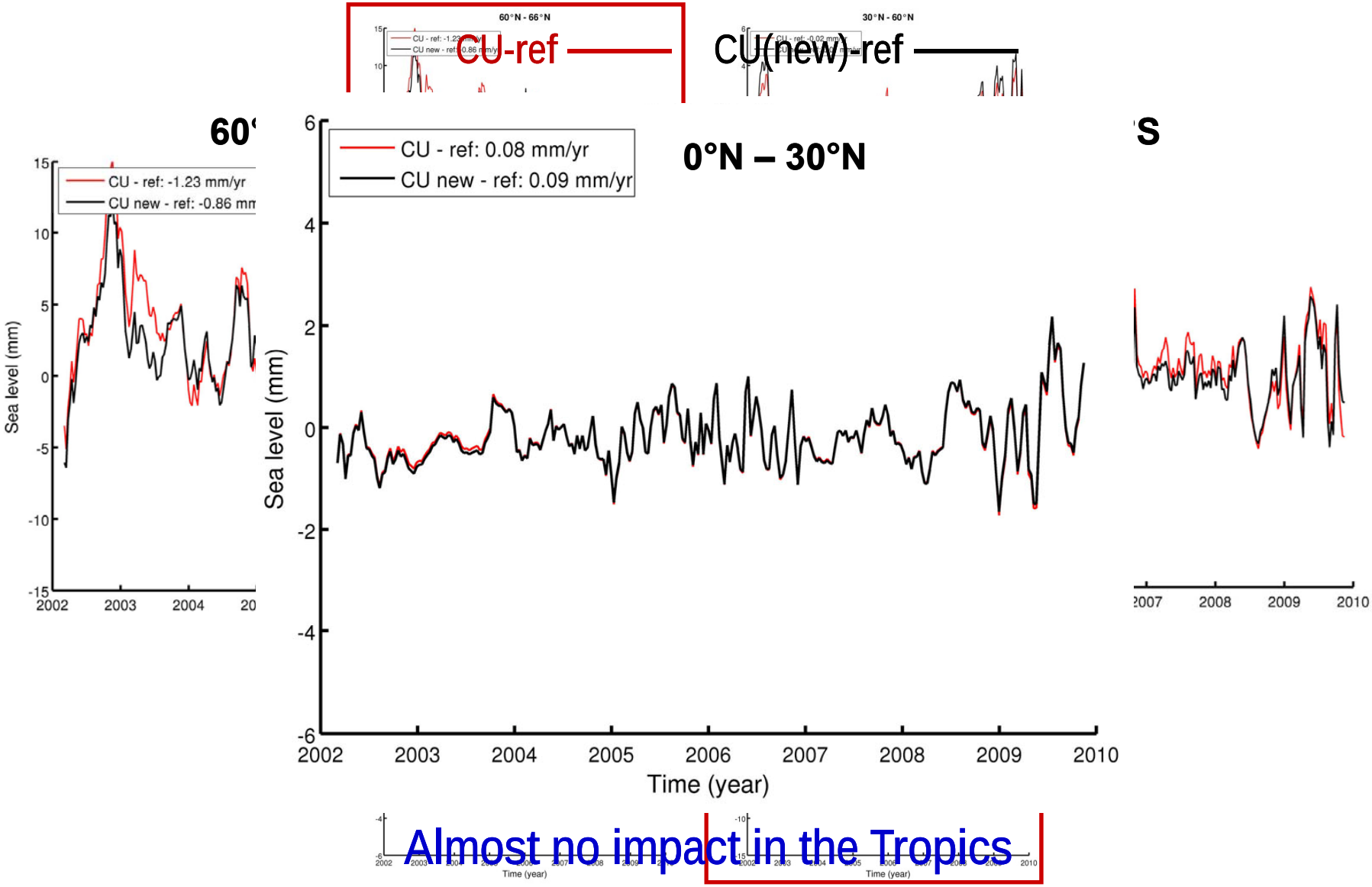
AVISO (new) differences with the reference for different latitude bands



Why no trend difference is observed between the two methods on the whole altimetry period ?



Effect of inclination-based weighting (compared to cos (lat) weighting) in along-track averaging process



Almost no impact in the Tropics

Conclusion

- Along track averaging versus model **underestimates** the GMSL trend **in high latitudes**

- 2°x2° gridding versus model **overestimates** the GMSL trend **in the tropics and northern high latitudes**

⇒ **grid cells** with **too few measurements** **contaminated** the AVISO global averaging result

⇒ corresponding improved processing will be implemented shortly by AVISO

- **The cause of the CU and AVISO underestimate of the GMSL trend at high latitudes remains obscure and will require further investigation**
- **When consider along-track or grid averaging, it is better to not consider data in high latitudes (> 60°N and <60°S)**

⇒ **GMSL trend is biased low**

Thank you for your attention !!

Recall

- **We need great precision for climate studies, for futur sea level projections, for sea level budget, and so on …**

- **We investigated Jason-1 period and made improvements (JMR correction, valid SSH measurements, …).**

- **But processings and error budget have always a non negligible impact.**

- **Other satellite data need more work and more investigation, in particular old missions (T/P, …).**

Results of the different tests performed

Criteria		Averaging methods			Differences	
Field	Field value	CU	AVISO	reference GMSL	CU-reference	AVISO-reference
Latitudinal coverage (MERCATOR control GMSL)	66°S-66°N	-	-	2,47 mm/yr	-	-
	90°S-90°N	-	-	2,42 mm/yr	-	-
Latitudinal bands (AVISO/CU)	60°N - 66°N	-1.76 mm/yr	-1.42 mm/yr	-0.56 mm/yr	-1.23 mm/yr	-0.89 mm/yr
	30°N - 60°N	2.55 mm/yr	2.41 mm/yr	2.57 mm/yr	-0.02 mm/y r	-0.15 mm/yr
	0°N - 30°N	1.96 mm/yr	2.12 mm/yr	1.94 mm/yr	0.08 mm/yr	0 .24 mm/yr
	30°S - 0°N	3.06 mm/yr	3.3 mm/yr	3.05 mm/yr	0.05 mm/yr	0. 29 mm/yr
	60°S - 30°S	2.34 mm/yr	2.45 mm/yr	2.38 mm/yr	-0.05 mm/y r	0.06 mm/yr
	66°S - 60°S	1.72 mm/yr	1.87 mm/yr	1.93 mm/yr	-0.15 mm/y r	0 mm/yr
Bathymetry (AVISO/CU)	0 m	2,36 mm/yr	2,54 mm/yr	2,47 mm/yr	-0,09 mm/yr	0,09 mm/yr
	120 m	2,3 mm/yr	2,49 mm/yr	2,47 mm/yr	-0,14 mm/yr	0,04 mm/yr
	500m	2,28 mm/yr	2,46 mm/yr	2,47 mm/yr	-0,17 mm/yr	0,01 mm/yr
Grid resolution (AVISO)	1°x1°	-	2,46 mm/yr	2,47 mm/yr	-	0,01 mm/yr
	2°x2°	-	2,54 mm/yr	2,47 mm/yr	-	0,09 mm/yr
	3°x3°	-	2,6 mm/yr	2,47 mm/yr	-	0,15 mm/yr
Weighting by the inverse distance in the gridding process (AVISO)		-	2,53 mm/yr	2,47 mm/yr	-	0,08 mm/yr
Measurements validity flag (AVISO/CU)		2,32 mm/yr	2,54 mm/yr	2,47 mm/yr	-0,13 mm/yr	0,09 mm/yr