

# Oceanographic validation of time variable gravity solutions from GRACE

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*(1) CNES/GRGS, Toulouse, France*

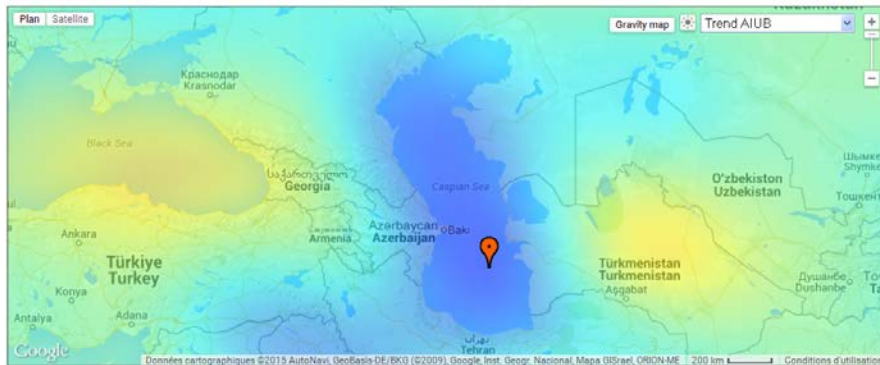
*(2) Géode & Cie, Toulouse, France*

*(3) GET/UMR5563/OMP/GRGS, Toulouse, France*

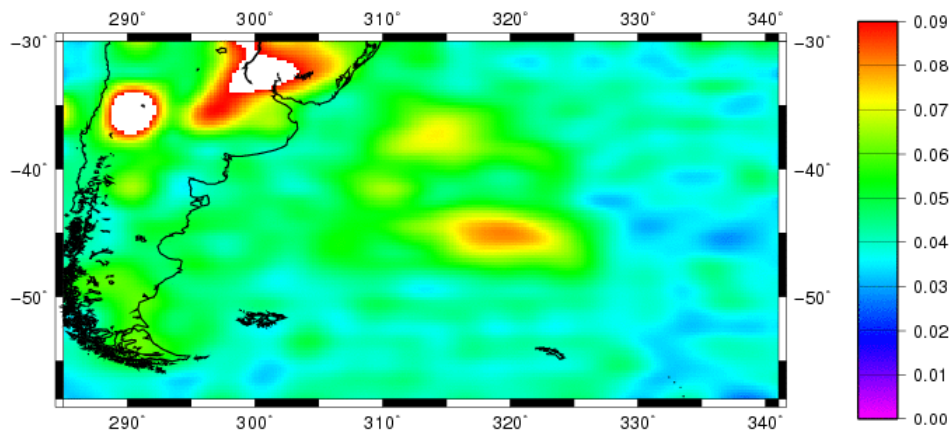
- ❖ **Interest of using some oceanic areas as a validation tool for GRACE products:**
  - Availability of precise and densely sampled time series from altimetry
  - The oceanic structures are usually larger than the continental ones → more compatible with GRACE resolution
- ❖ **Conditions:**
  - The presence of noticeable mass signal in the GRACE solutions
  - Altimeter heights have to be corrected for the steric component and for the loading effect

## ❖ Test zones:

### ➤ Inland sea: the Caspian sea



### ➤ Open ocean: the Zapiola gyre



## ❖ Data used:

### ➤ Altimetry:

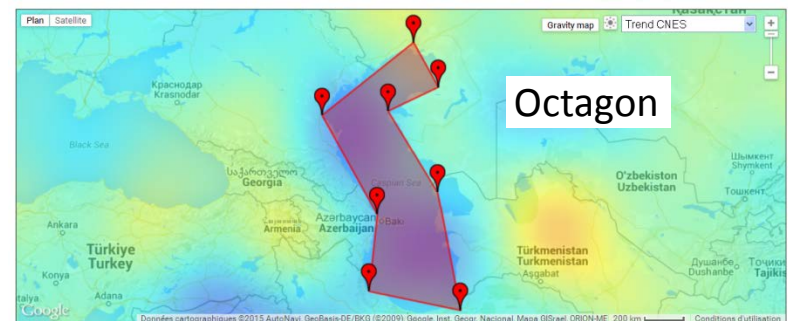
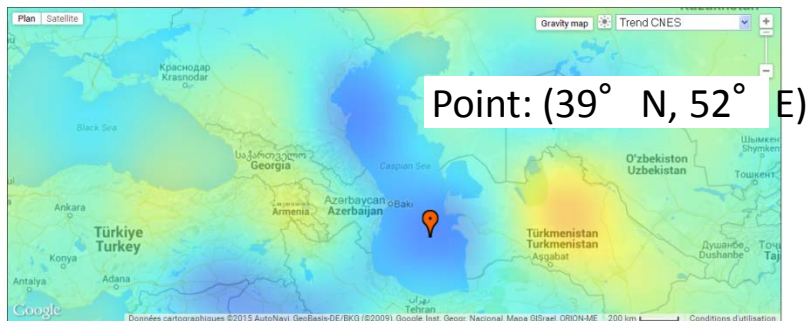
- open ocean: **AVISO+** (Multi-satellite Gridded Sea Level Anomalies SSALTO/Duacs ) daily
- inland seas: **HYDROWEB** (Cretaux et al. 2011) 10-day

### ➤ **GRACE time series** (monthly solutions)\*:

- **AIUB RL02** (DDK-5 filtered)
- **CNES/GRGS RL03-v1** (unfiltered)
- **CSR RL05** (DDK-5 filtered)
- **GFZ RL05a** (DDK-5 filtered)
- **JPL RL05** (DDK-5 filtered)
- **TUGRAZ ITSG14** (DDK-5 filtered)

\* All available from the ICGEM web site in unfiltered and DDK-1/2/3/4/5 versions

- The largest enclosed inland body of water on Earth: 370,000 km<sup>2</sup> (400 x 900 km)
- Accurate altimeter time series
- Can test the ability of the GRACE solutions to provide spatially pertinent information
- GRACE point-wise and basin-wise time series are tested:

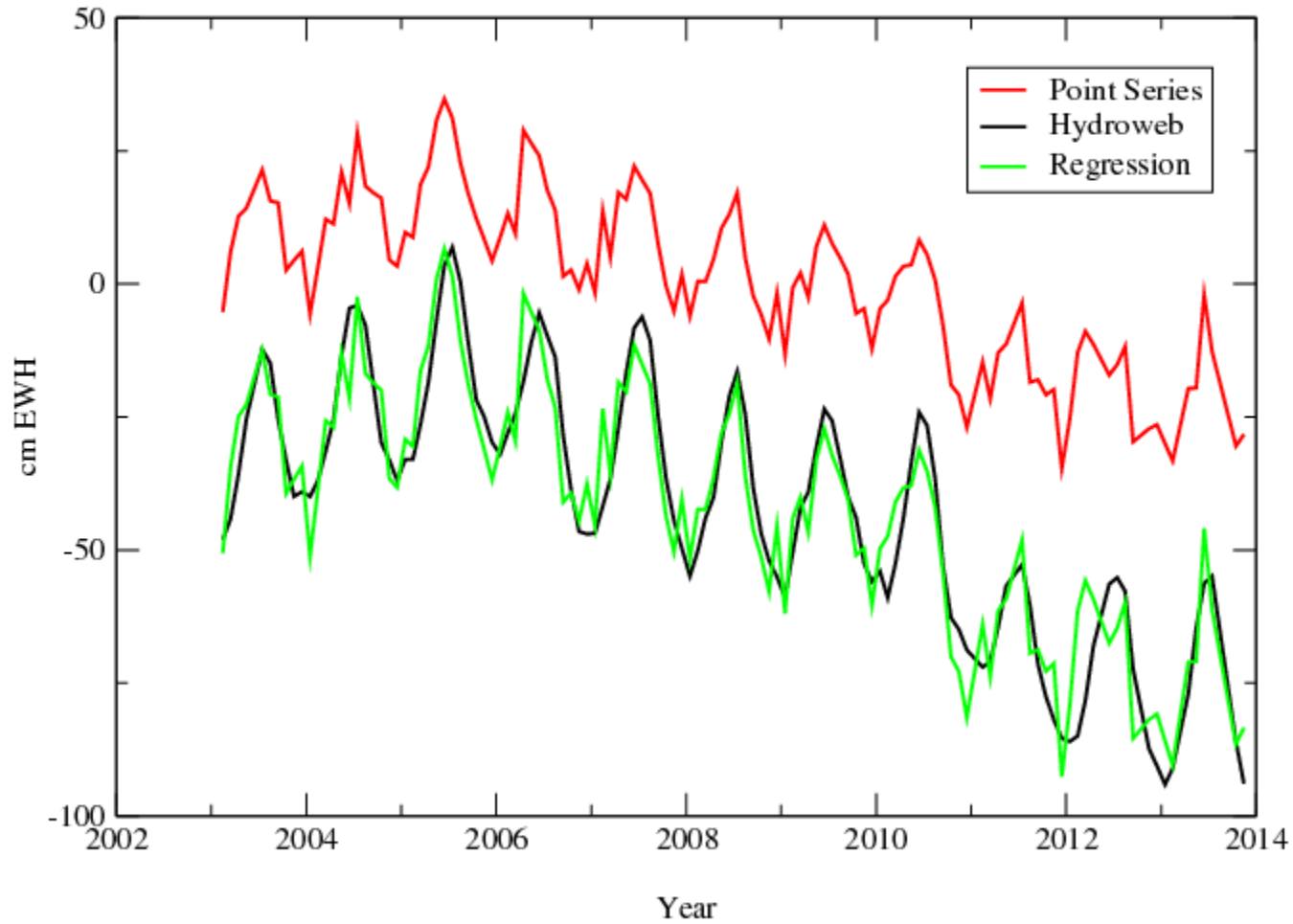


- Test mostly valid in a relative sense; an absolute calibration would require more sophisticated methods (averaging kernel, land hydrology and steric effect removal, cf. Swenson & Wahr 2007)

# 1- Caspian sea

## TUGRAZ ITSG14 (DDK-5 filtered)

Point (39°N, 52°E) series



	Correlation		Scale Factor	
	Point	Basin	Point	Basin
AIUB RL02	0.91	0.94	1.32	1.67
CNES/GRGS RL03-v1	0.96	0.98	1.27	1.75
CSR RL05	0.91	0.93	1.37	1.68
GFZ RL05a	0.86	0.80	1.28	1.39
JPL RL05	0.89	0.89	1.28	1.53
TUGRAZ ITSG14	0.95	0.96	1.43	1.69

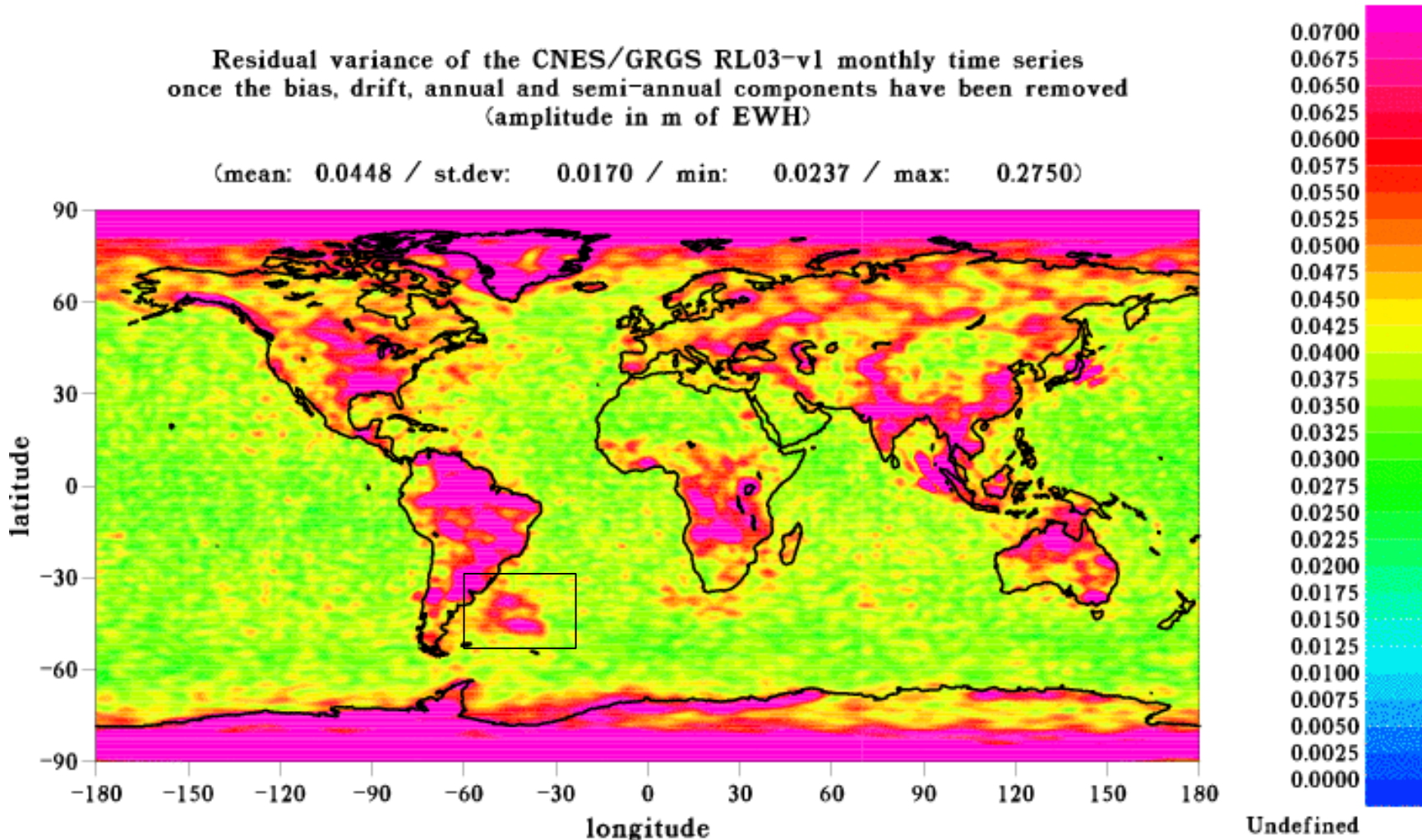
- Correlation is slightly better for basin-average than for point
  - ➔ **Less noise in the basin-average than in the point time series**
- BUT scale factor is much higher for basin-average than for point
  - ➔ **The point time series is closer to the actual sea level**

**Best correlation is 98 %, best scale factor is 1.27**

## ❖ Large non-periodic mass signal in the GRACE series

Residual variance of the CNES/GRGS RL03-v1 monthly time series  
once the bias, drift, annual and semi-annual components have been removed  
(amplitude in m of EWH)

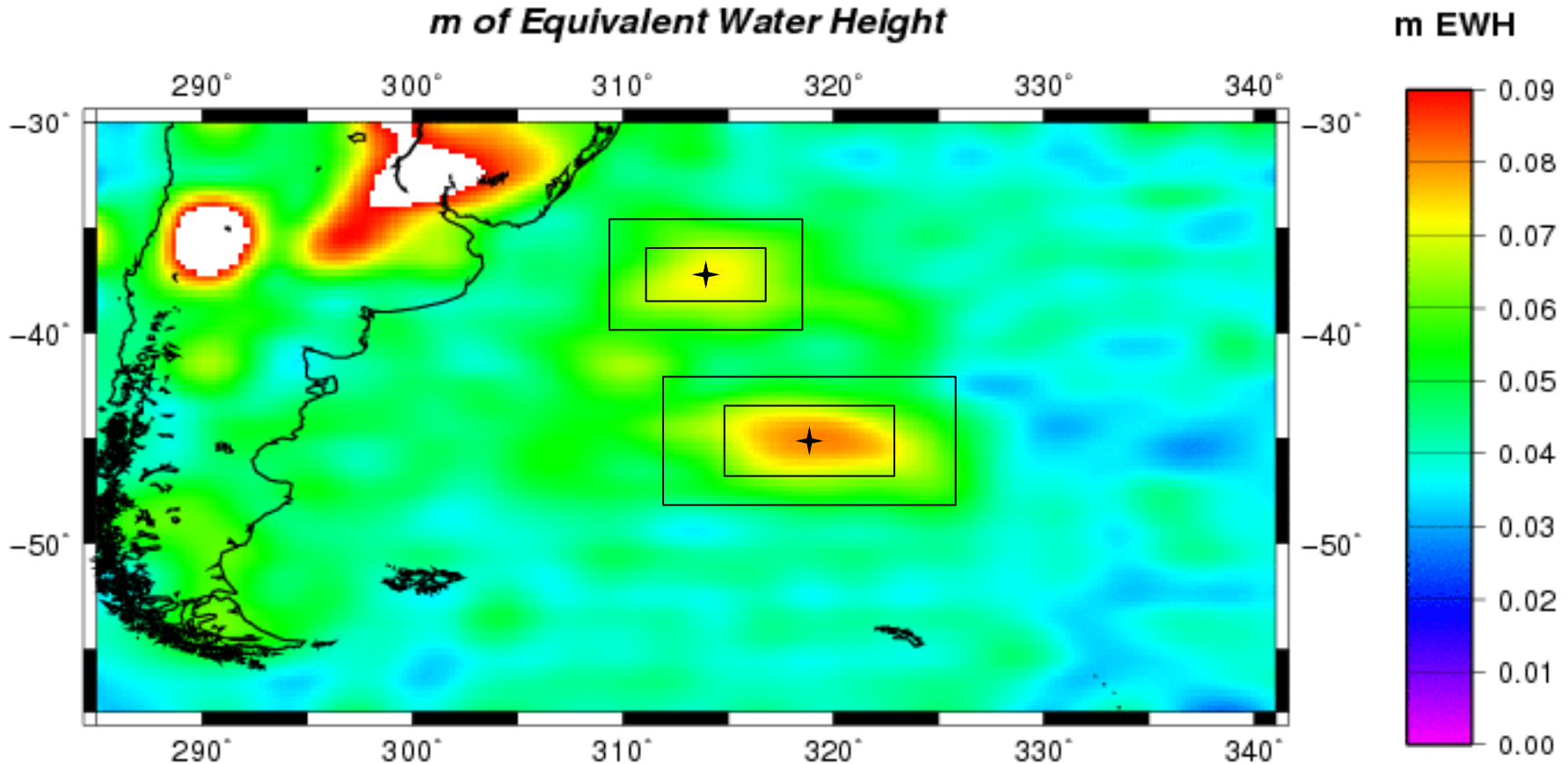
(mean: 0.0448 / st.dev: 0.0170 / min: 0.0237 / max: 0.2750)





# 2- Zapiola gyre

Non periodic variability from CNES/GRGS RL03-v1 series



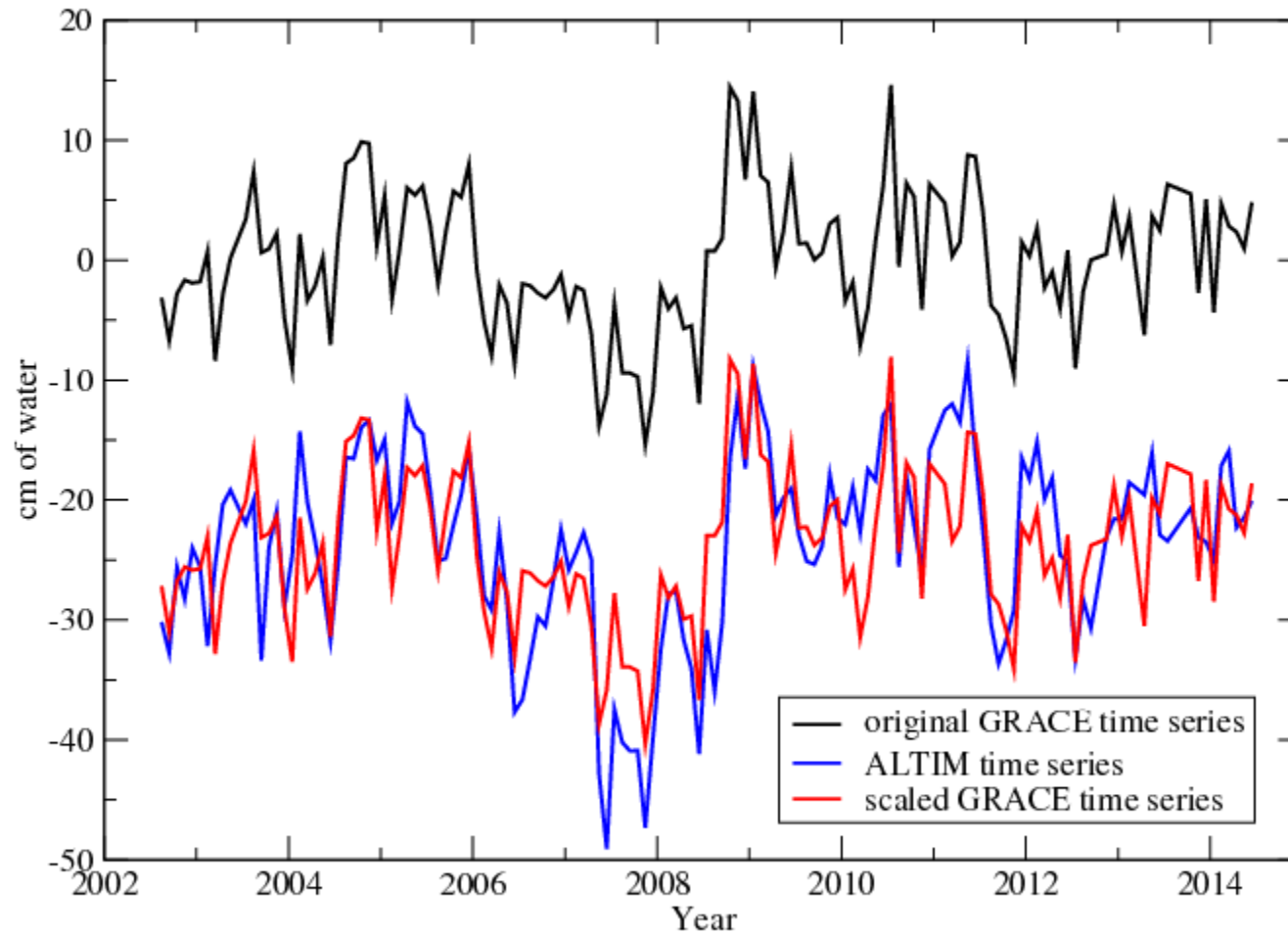
- Point coordinates: ( $37^{\circ}$  S,  $46^{\circ}$  W) and ( $45^{\circ}$  S,  $41^{\circ}$  W)
- Small rectangle area: north  $\sim 316,000$  km<sup>2</sup>, south  $\sim 280,000$  km<sup>2</sup>
- Large rectangle area: north  $\sim 592,000$  km<sup>2</sup>, south  $\sim 1,120,000$  km<sup>2</sup>



# 2- Zapiola gyre

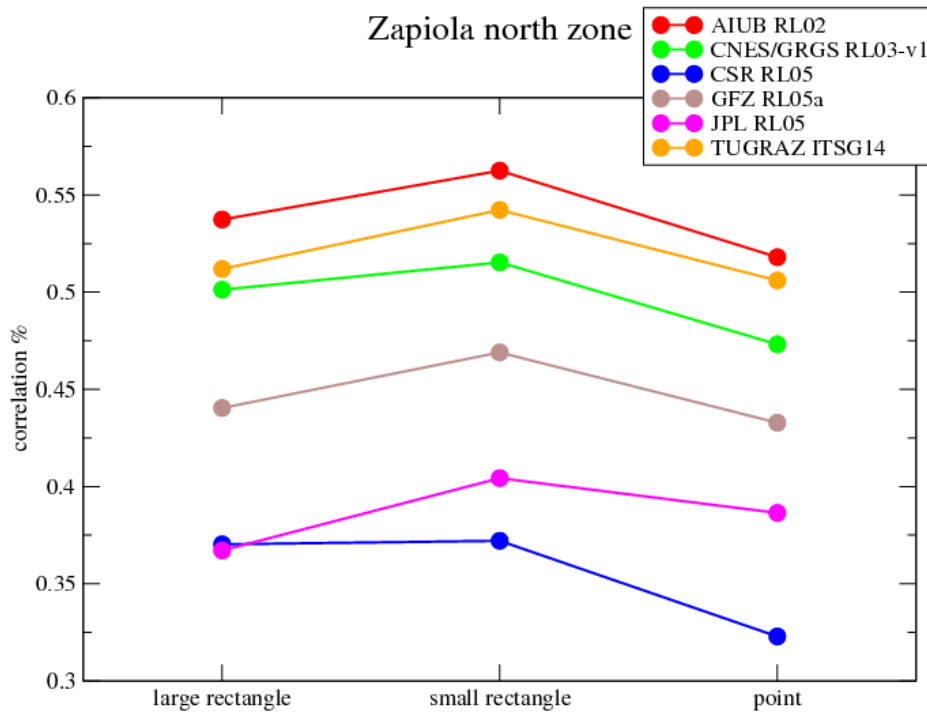
Best correlation : Zapiola south zone, small rectangle

correlation: 78 %, scale factor = 1.07

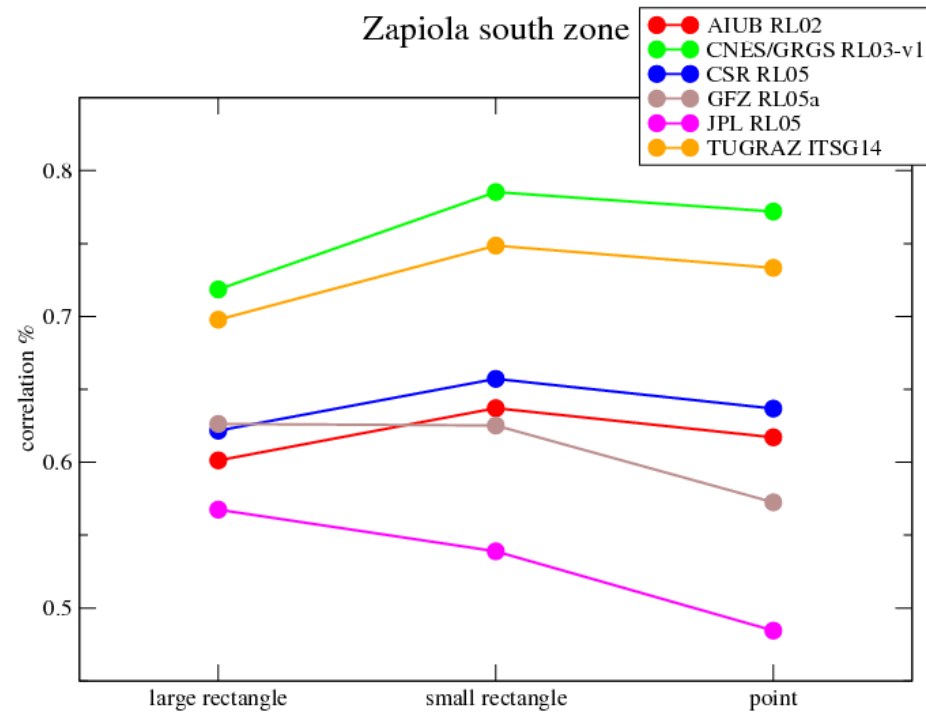


# 2- Zapiola gyre

Zapiola north zone



Zapiola south zone



- The best coherence between altimetry and GRACE is achieved for areas ~ 300,000 km<sup>2</sup>
- Agreement is much better for the south zone than for the north zone
- Best coherence in the south zone = 79 % with a scale factor of 1.07
- Worst coherence in the north zone = 37 % with a scale factor of 0.66

- Altimetry can be a precious tool for GRACE solutions validation
- The selected oceanic areas must present a large mass signal
- They can be far off-coast and therefore escape contamination from continental hydrology
- In the Caspian sea we can reach a very high level of coherence between altimetry and GRACE (98 %) although it is an enclosed sea
- For some time series, the low correlations do not come from the smoothing by DDK-5, but from the intrinsic noise of the time series
- In the Zapiola gyre the variability of the ocean is higher than in the Caspian – spatially and temporally - and is more difficult to capture it with monthly time series from GRACE (max. correlation 79 %)
- The example of the Zapiola gyre shows that in some cases (Zapiola north) the monthly time sampling is not sufficient  
We must go to a shorter time sampling...

Thank you for your attention