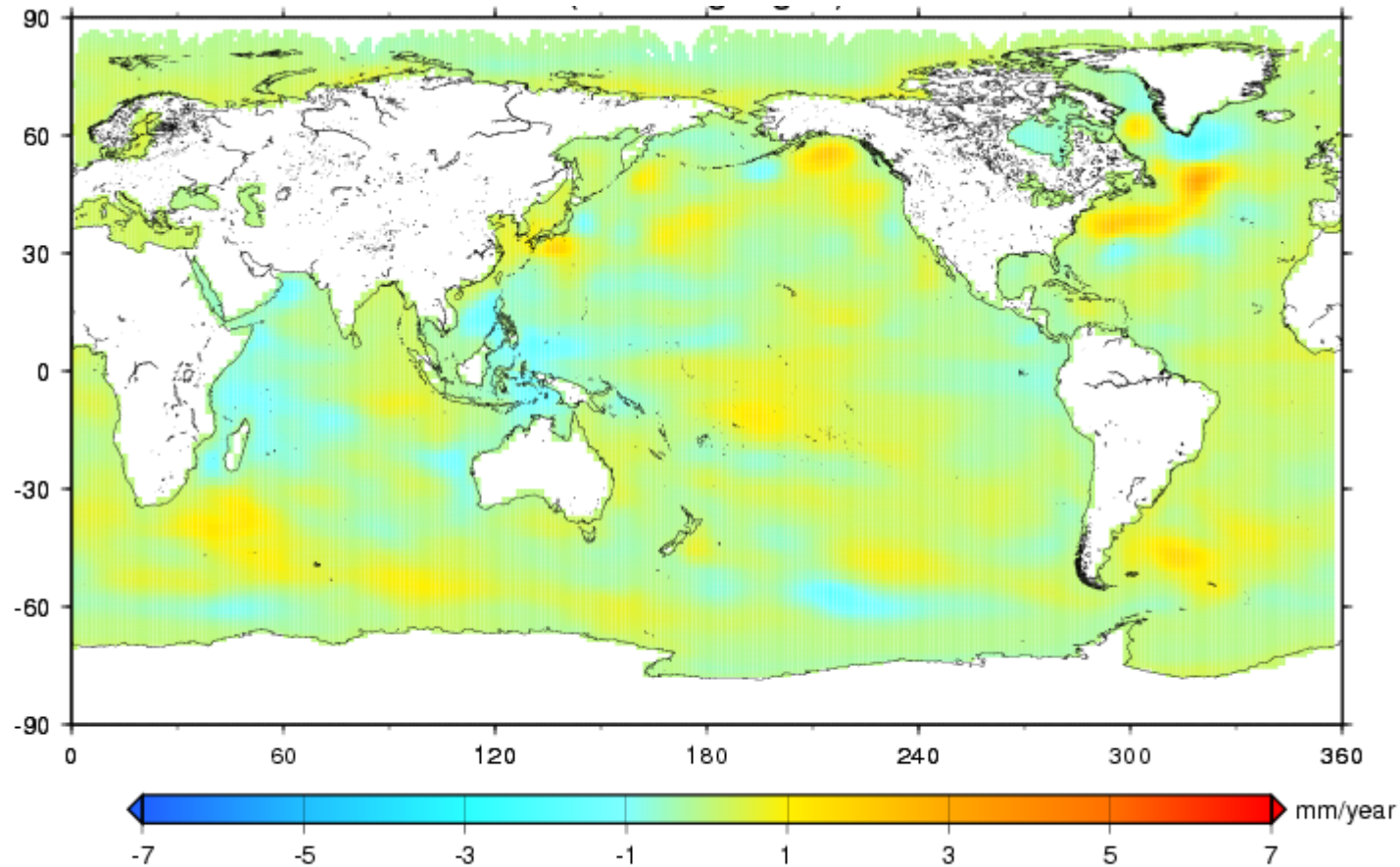# Reconstruction of the Mediterranean Sea Level Variability over 1970-2006 derived from Altimetry and 2 long OGCM Runs.

B. Meyssignac, F.M. Calafat , S. Somot, V. Rupolo,
P.Stocchi, W. Llovel, A. Cazenave and R. Morrow.
LEGOS-CNES, Toulouse, France

What was the sea level variability in the Mediterranean over the last 40 years?
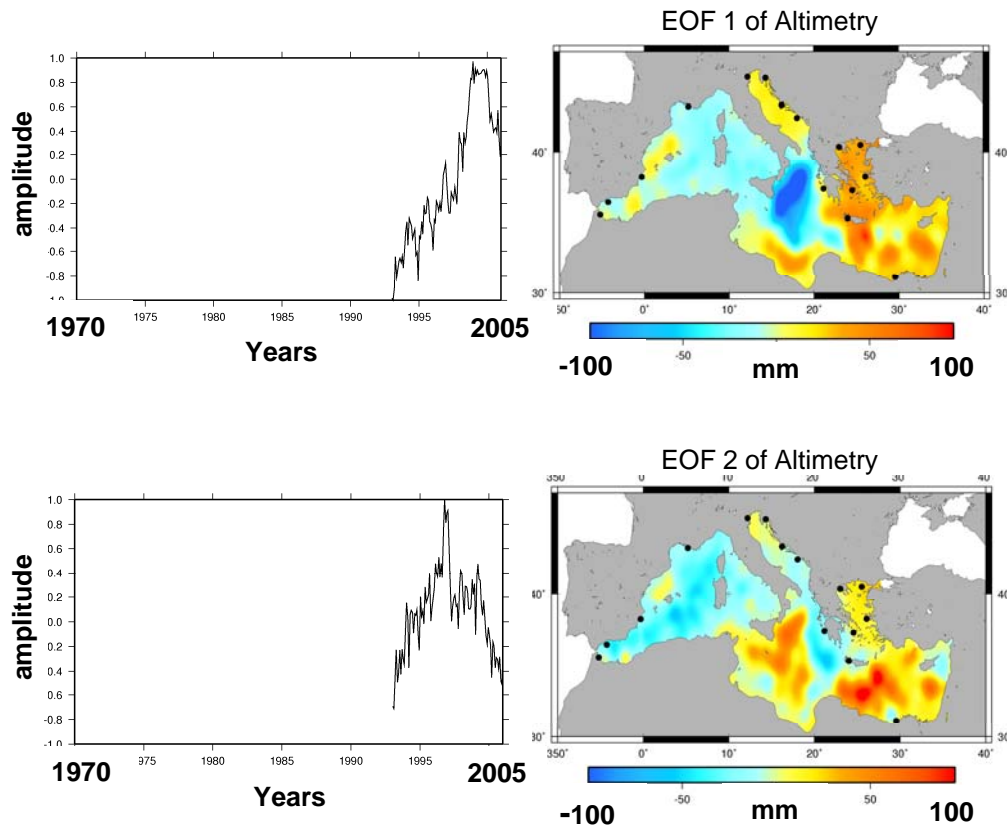
Is reconstructed sea level on global scale (Church et al (2004), Llovel et al (2009)) representative at a regional scale (e.g. Mediterranean sea)?
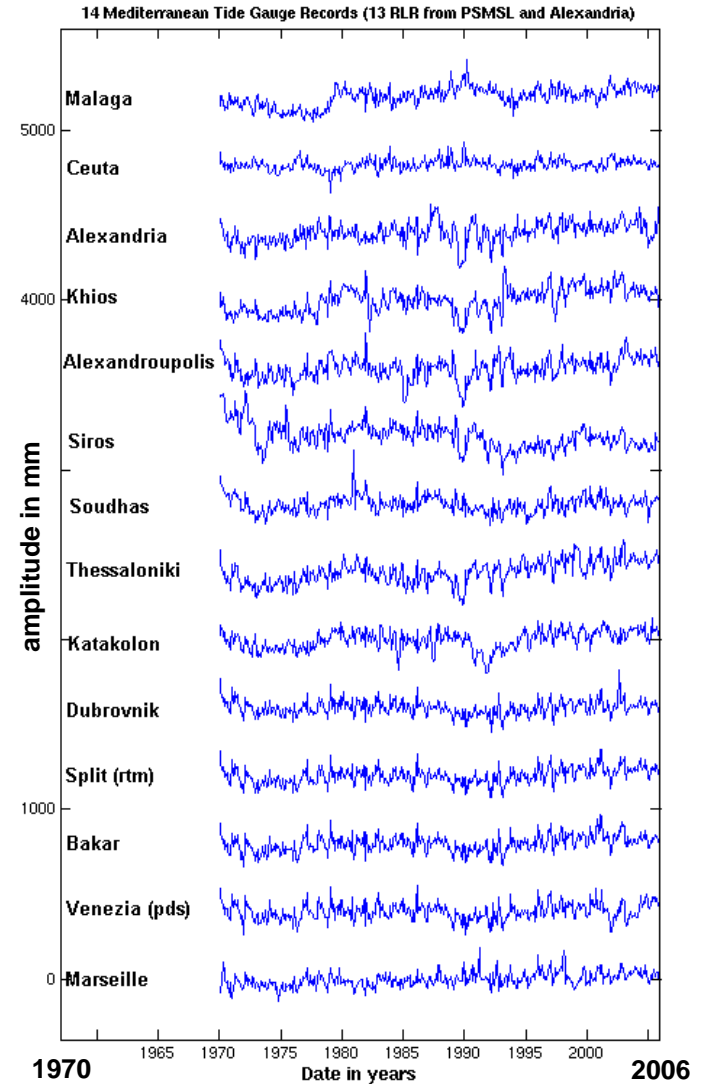

Spatial trend patterns of reconstructed sea level over 1950-2003 from OPA/ORCA simulation and 99 tide gauge records (from Llovel et al. 2009 and Meyssignac et al., 2010)

Sea level Reconstruction method for the Mediterranean Basin

- Method: optimal interpolation of Kaplan et al (2000)
  dedicated to the Mediterranean basin.

EOF 1 of Altimetry

EOF 2 of Altimetry

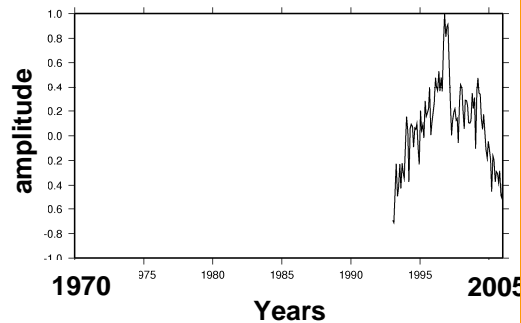14 Mediterranean Tide Gauge Records (13 RLR from PSMSL and Alexandria)

EOFs of a 2-D well resolved sea level field

14 long tide gauges series

Sea level Reconstruction method for the Mediterranean Basin

- Method: optimal interpolation of Kaplan et al (2000) dedicated to the Mediterranean basin.
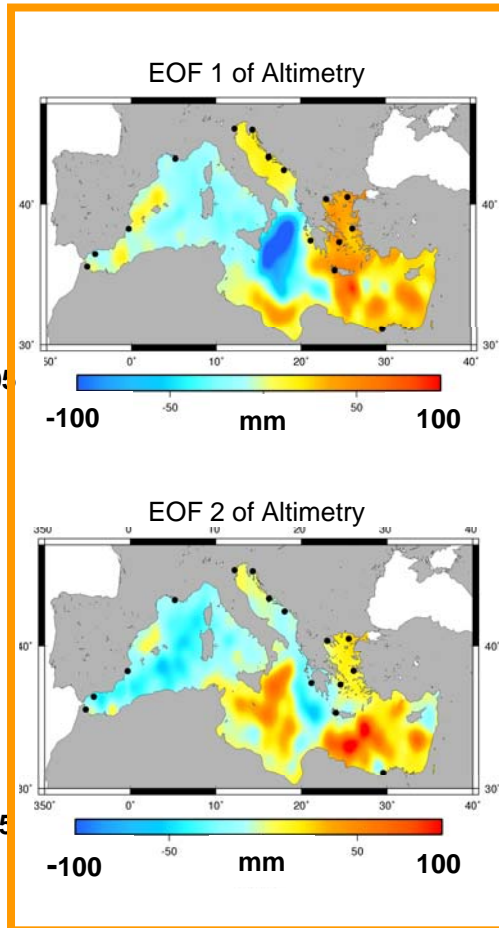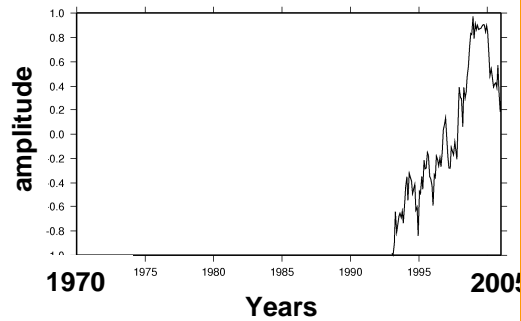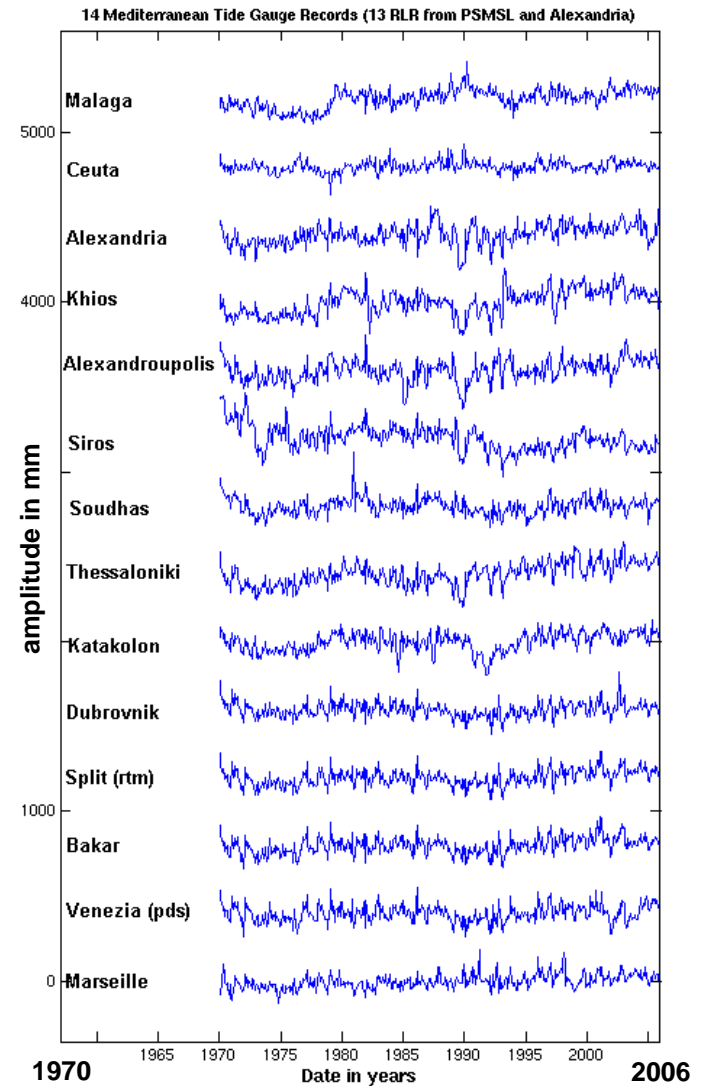

EOF 1 of Altimetry

EOF 2 of Altimetry

-100   mm   100

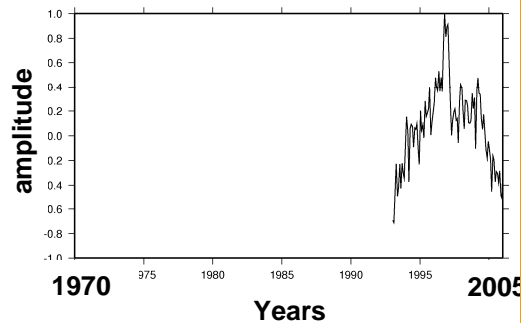14 Mediterranean Tide Gauge Records (13 RLR from PSMSL and Alexandria)

EOFs of a 2-D well resolved sea level field

14 long tide gauges series

Sea level Reconstruction method for the Mediterranean Basin

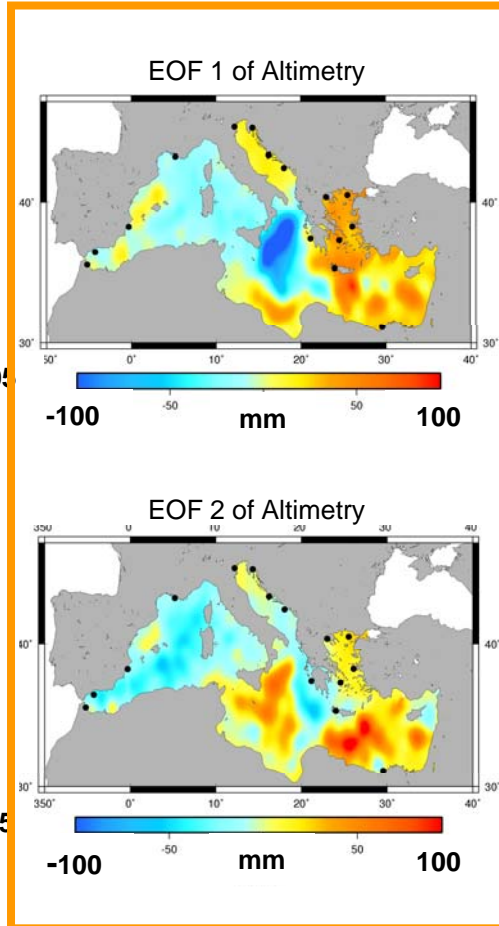- Method: optimal interpolation of Kaplan et al (2000) dedicated to the Mediterranean basin.
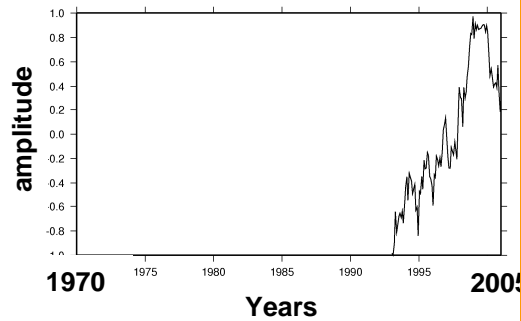

EOF 1 of Altimetry

EOF 2 of Altimetry

+

14 Mediterranean Tide Gauge Records (13 RLR from PSMSL and Alexandria)

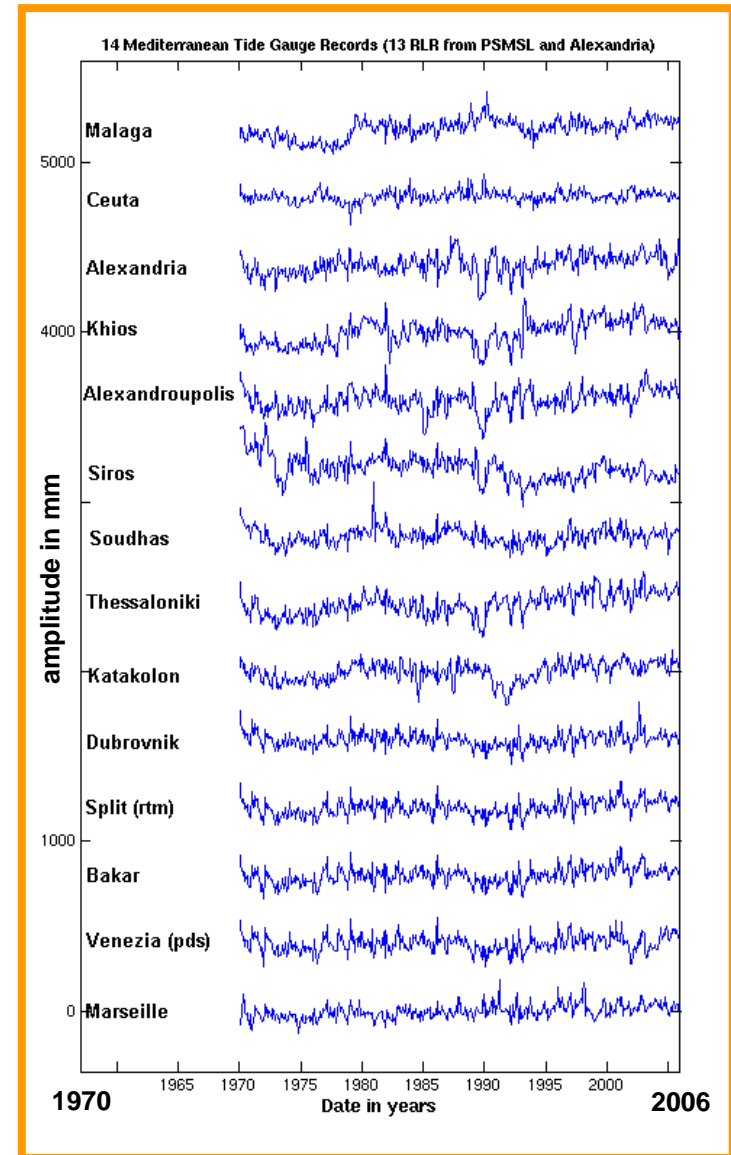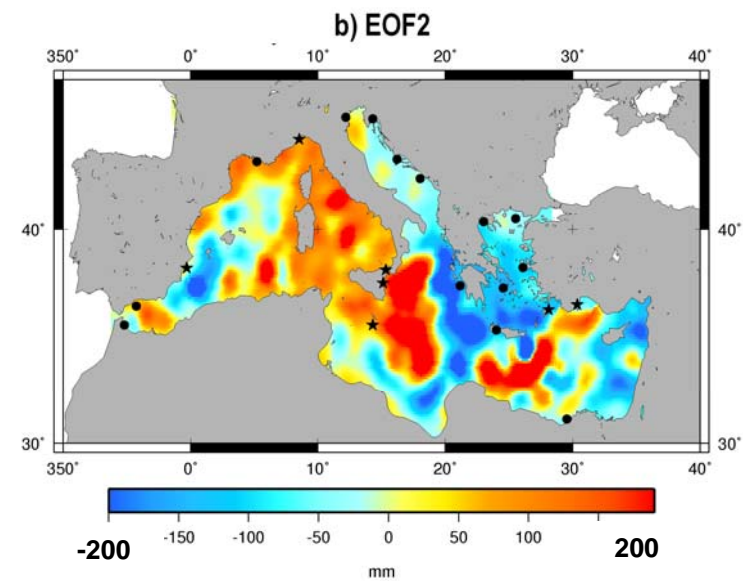EOFs of a 2-D well resolved sea level field

14 long tide gauges series

Sea level Reconstruction method for the Mediterranean Basin

- Method: optimal interpolation of Kaplan et al (2000)
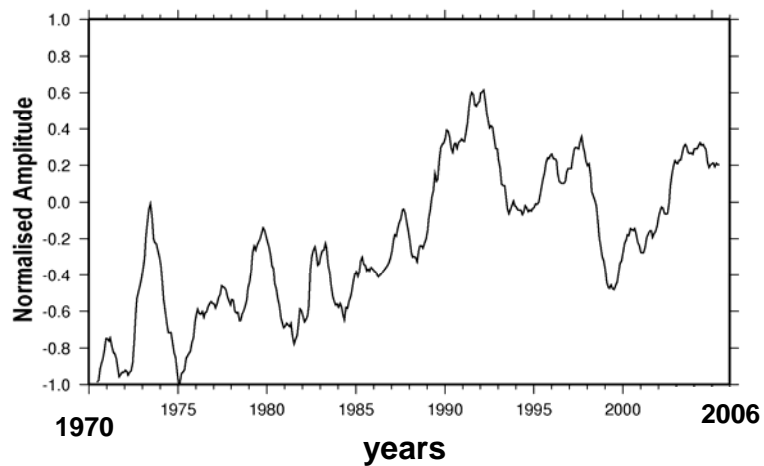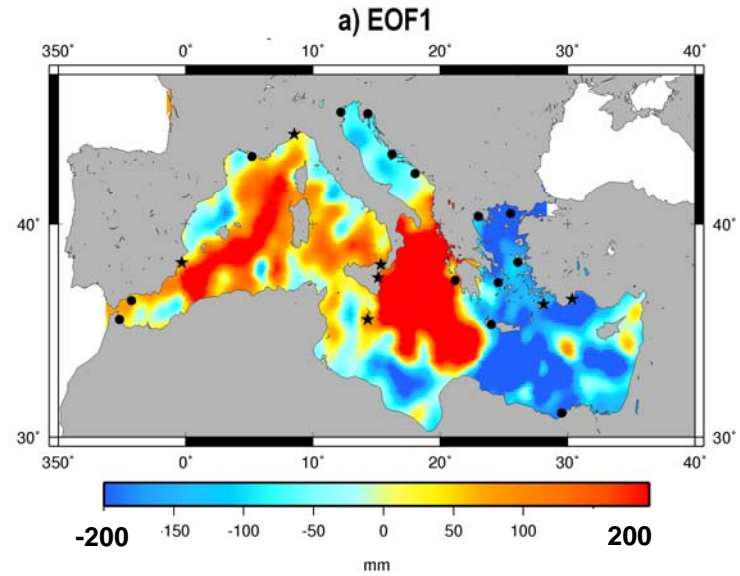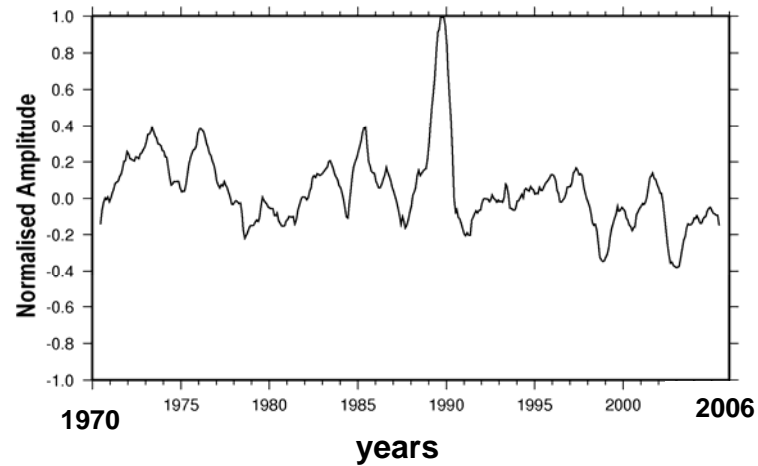 dedicated to the Mediterranean basin.

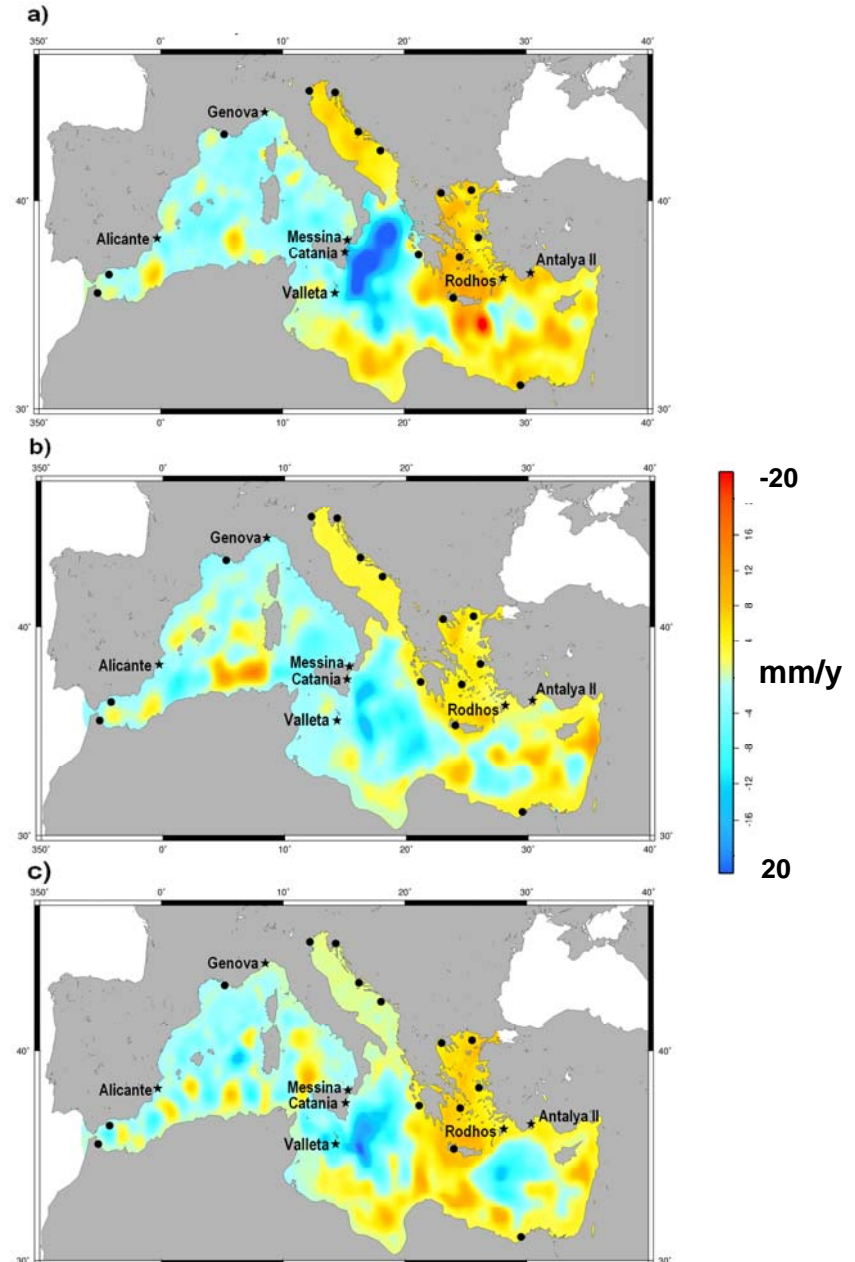# Sea level Reconstruction method for the Mediterranean Basin

In this study : 3 different reconstructions

- EOFs of 3 different spatial fields:
  a) Altimetry: 1993-2005: Calafat and Gomis (2009)
  b) NEMOMED8: ERA-40 forced model, 1970-2002
  c) PROTHEUS System: coupled model, 1970-2002

- 14 long tide gauge series:
  13 RLR records from PSMSL: www.psmsl.org
  + the record of Alexandria : Frihy (2003)

Validation with altimetry and independent tide gauges
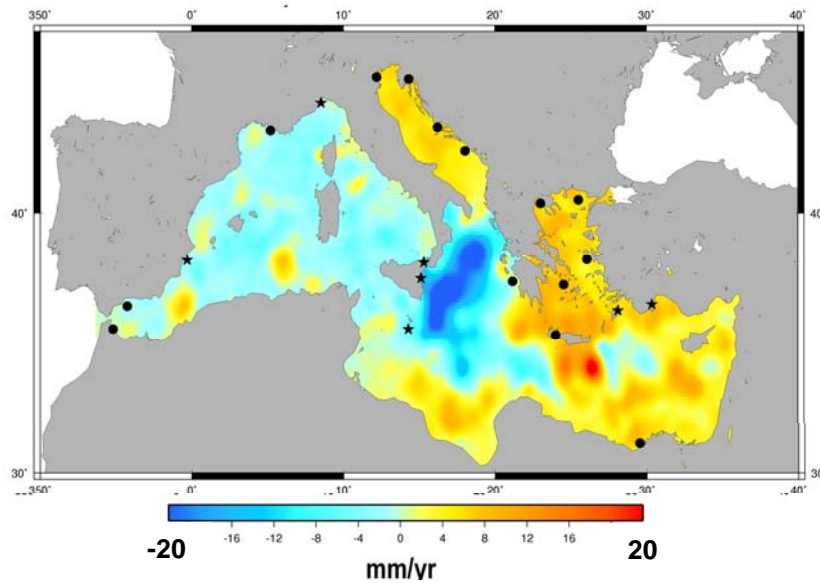
- Comparison with 7 tide gauge records
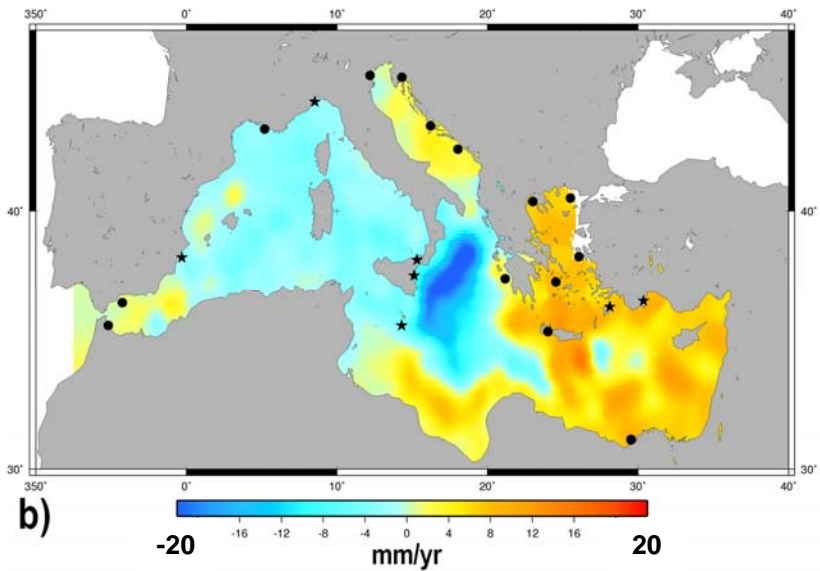 4 RLR records from PSMSL
  3 records from IDROMARE: www.idromare.it

Sea level trends over 1993-2005

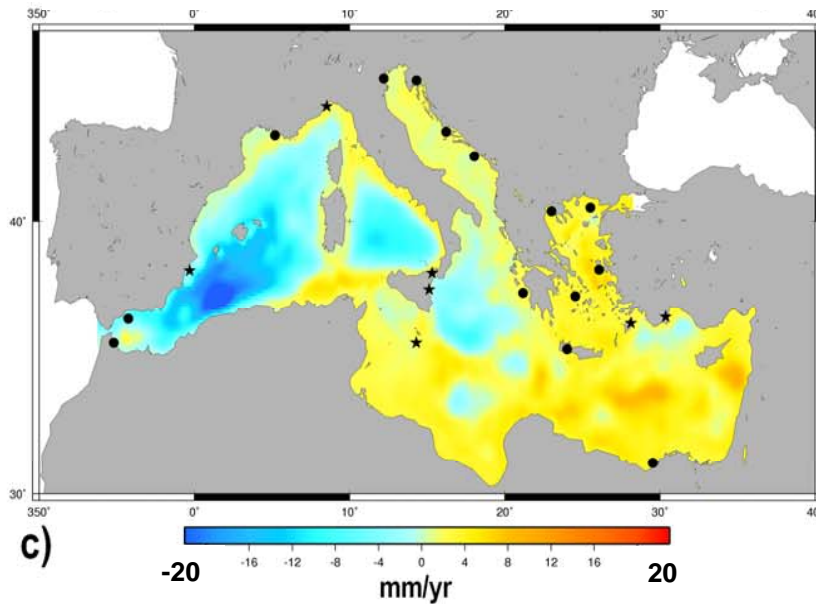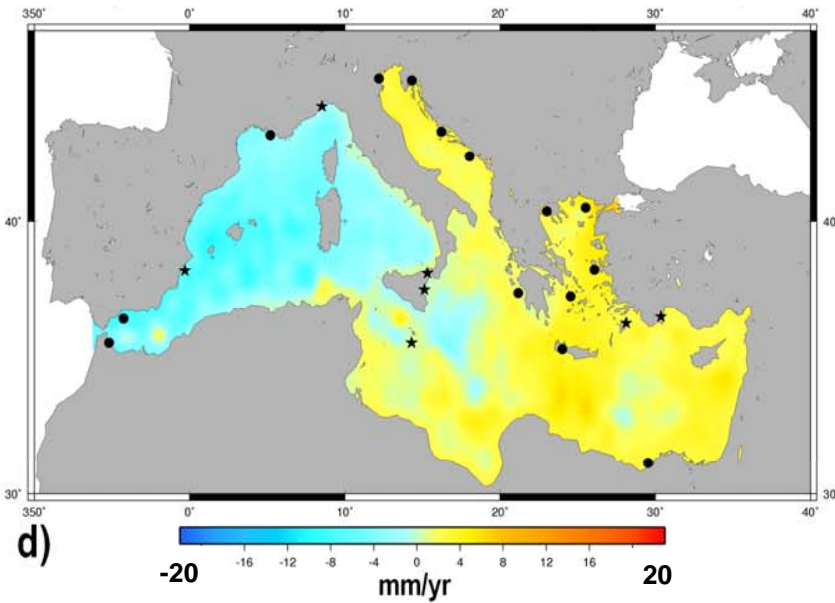# Mediterranean Sea level Reconstruction results: trends over 1993-2001

Mediterranean Sea level Reconstruction results: comparison with independent TG

TG	Altimetry reconstruction		PROTHEUS reconstruction		NEMOMED8 reconstruction	
	Corr → 2001	Trend diff → 2001	Corr → 2001	Trend diff → 2001	Corr → 2001	Trend diff → 2001
Alicante	**0.67**	-0.3 ±0.4	**0.44**	0.0 ±0.7	**0.50**	1.9 ±0.5
Genova	**0.54**	-1.8 ±1.0	**0.42**	-3.4 ±1.1	**0.59**	-1.1 ±1.0
Antalya II	**0.48**	1.8 ±2.3	**0.47**	-2.5 ±2.0	**0.46**	-2.6 ±2.1
Rodhos	**0.39**	1.07 ±0.9	**0.55**	1.6 ±0.7	**0.56**	1.3 ±0.7
Valleta	**0.45**	-2.8 ±2.1	**0.36**	2.9 ±2.6	**0.32**	0.7 ±2.8
Catania	**0.54**	-6.9 ±4.9	**0.67**	0.2 ±4.7	**0.69**	-0.4 ±4.2
Messina	**-0.08**	-27.4 ±6.6	**0.30**	-17.5 ±6.8	**0.31**	-18.1 ±6.7

b) C&G Reconstruction
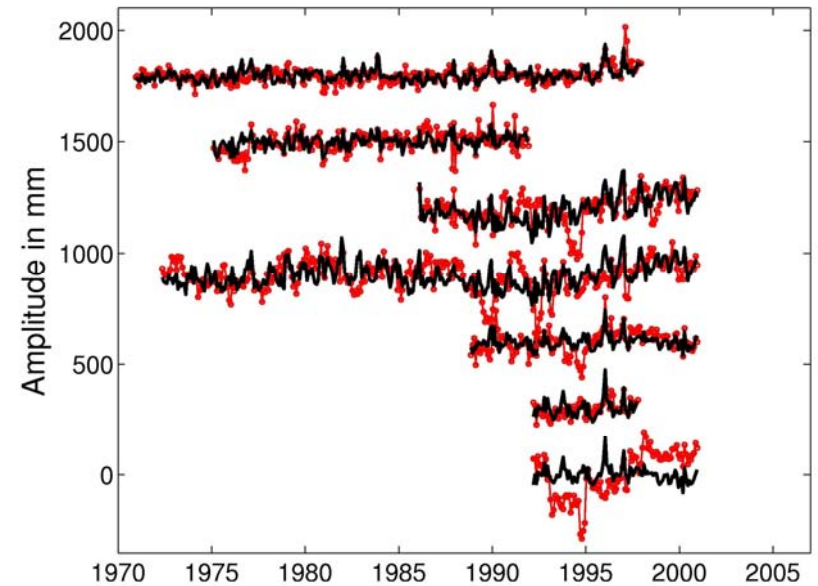

c) PS Reconstruction
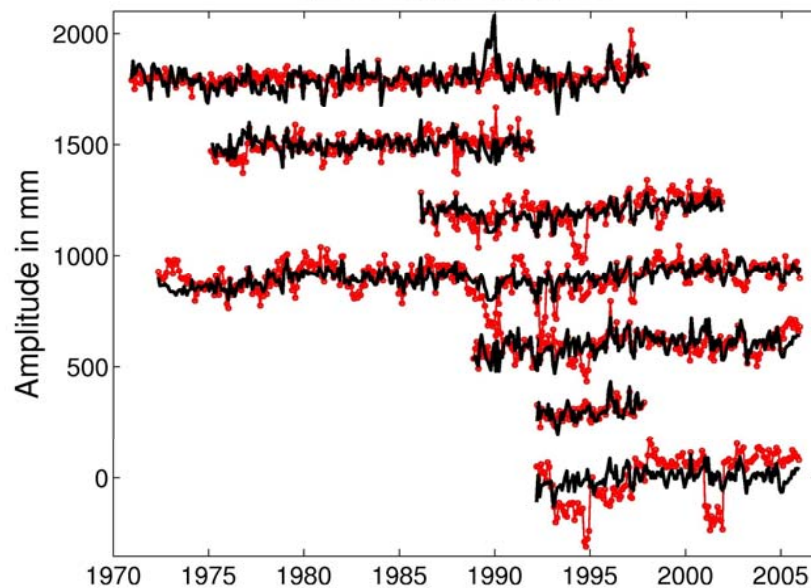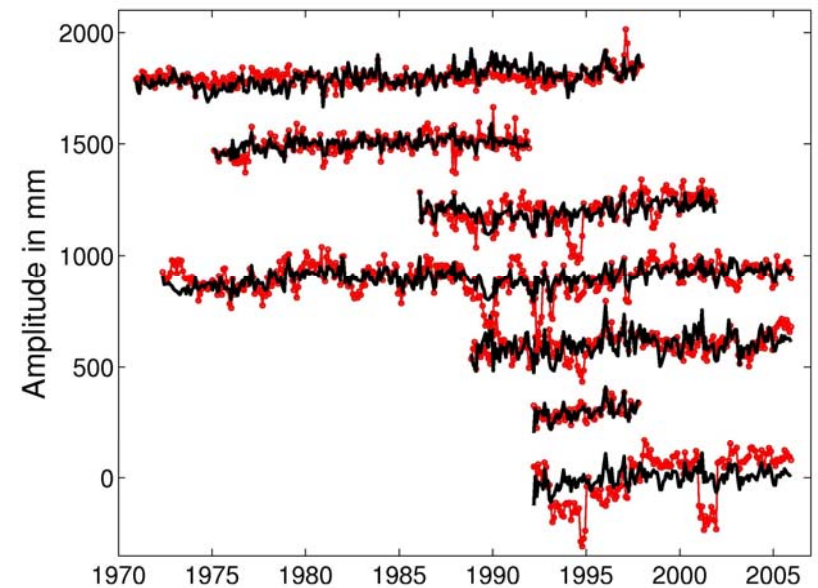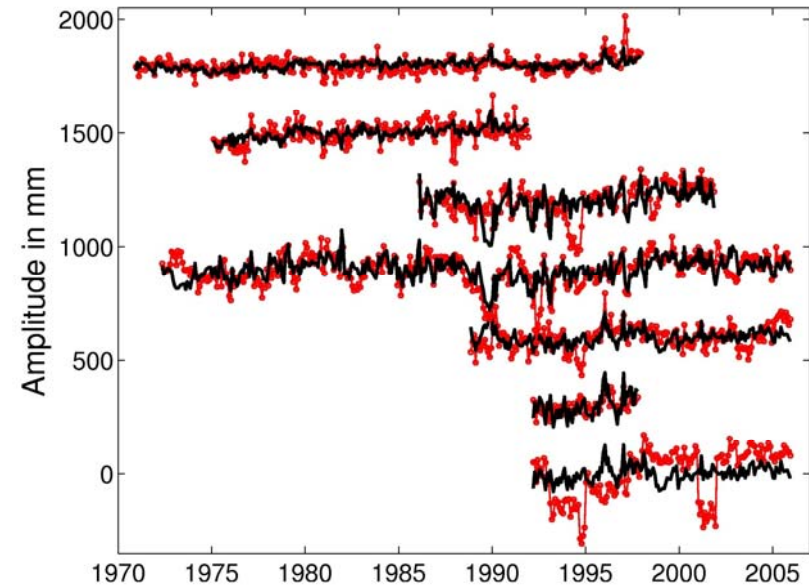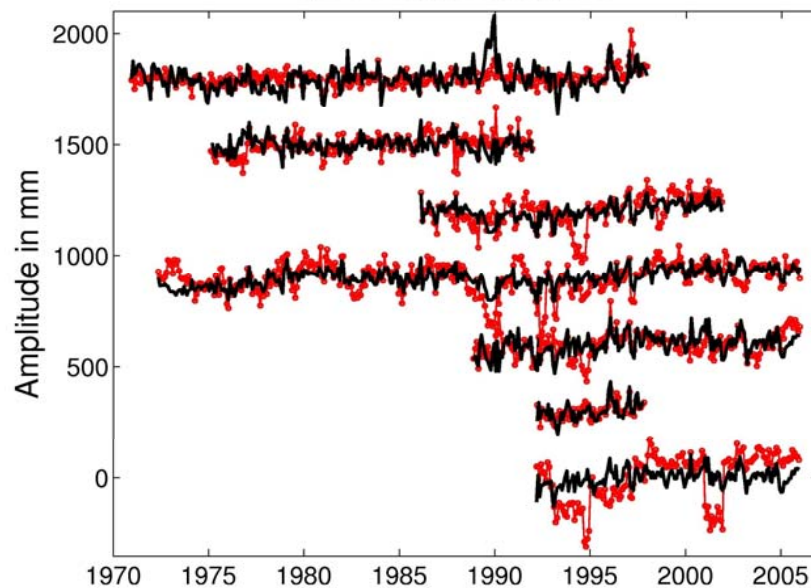

d) NM8 Reconstruction

Mediterranean Sea level Reconstruction results: comparison with independent TG

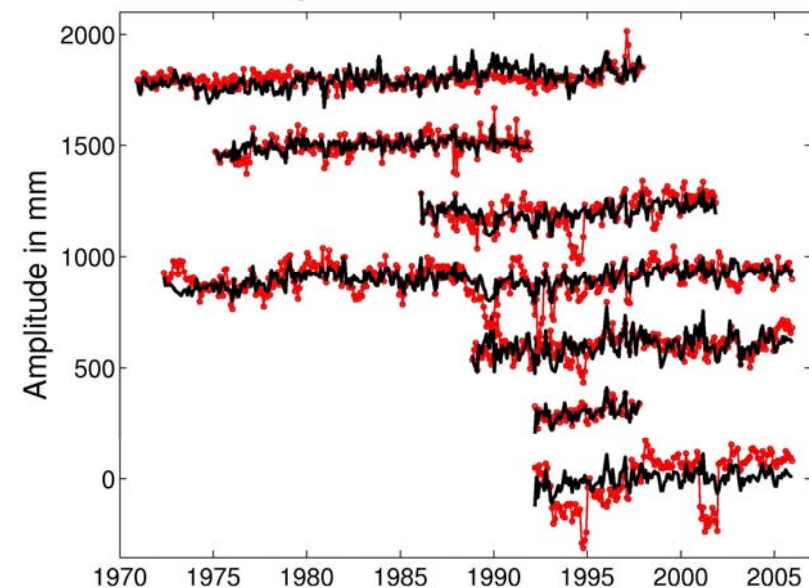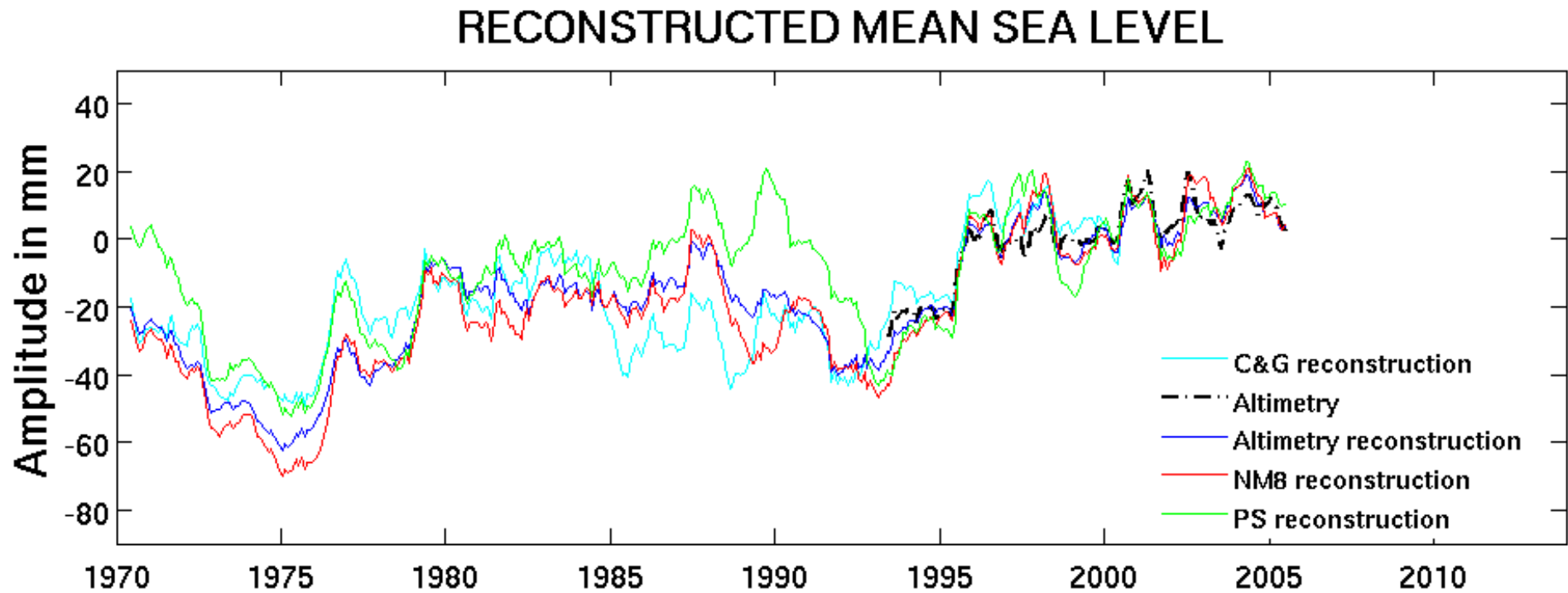| TG	Altimetry reconstruction		PROTHEUS reconstruction		NEMOMED8 reconstruction	
	Corr → 2006	Trend diff → 2006	Corr → 2006	Trend diff → 2006	Corr → 2006	Trend diff → 2006
Alicante	**0.59**	-0.1 ±0.4	**0.44**	-0.1 ±0.7	**0.50**	1.9 ±0.5
Genova	**0.49**	0.2 ±1.1	**0.41**	-3.4 ±1.1	**0.59**	-1.1 ±1.0
Antalya II	**0.46**	-2.2 ±2.1	**0.51**	-3.0 ±1.8	**0.50**	-3.1 ±1.8
Rodhos	**0.55**	0.0 ±0.6	**0.54**	1.1 ±0.6	**0.55**	0.8 ±0.5
Valleta	**0.27**	-2.1 ±1.4	**0.40**	0.2 ±1.5	**0.39**	-0.5 ±1.6
Catania	**0.51**	3.2 ±6.6	**0.67**	0.1 ±4.7	**0.69**	-0.4 ±4.2
Messina	**0.16**	-12.4 ±3.7	**0.28**	-11.7 ±3.6	**0.32**	-11.0 ±3.6

a) Altimetry Reconstruction

c) PS Reconstruction

d) NM8 Reconstruction

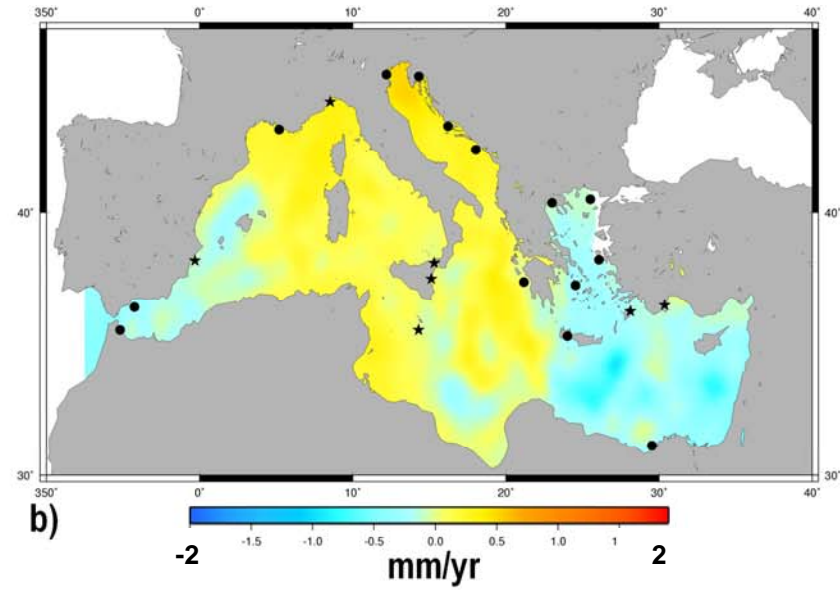# Mediterranean Sea level Reconstruction results: Mean Sea Level

RECONSTRUCTED MEAN SEA LEVEL

C&G reconstruction
Altimetry
Altimetry reconstruction
NM8 reconstruction
PS reconstruction

Mediterranean Sea level Reconstruction results: Maps of Trends 1970-2001

Altimetry

a)

-3 ... **mm/yr** ... **3**
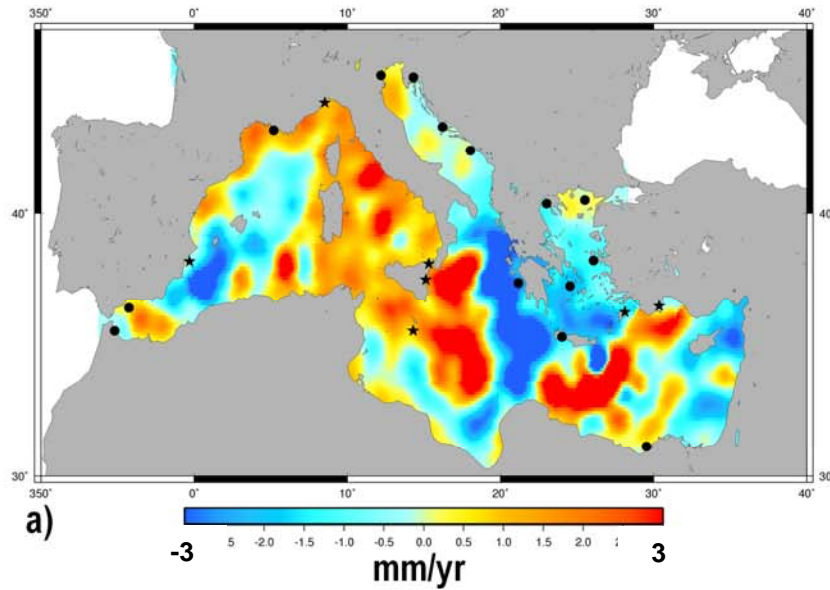
Altimetry reconstruction (Calafat and Gomis, 2009)

b)

-2 ... **mm/yr** ... **2**

Protheus System reconstruction
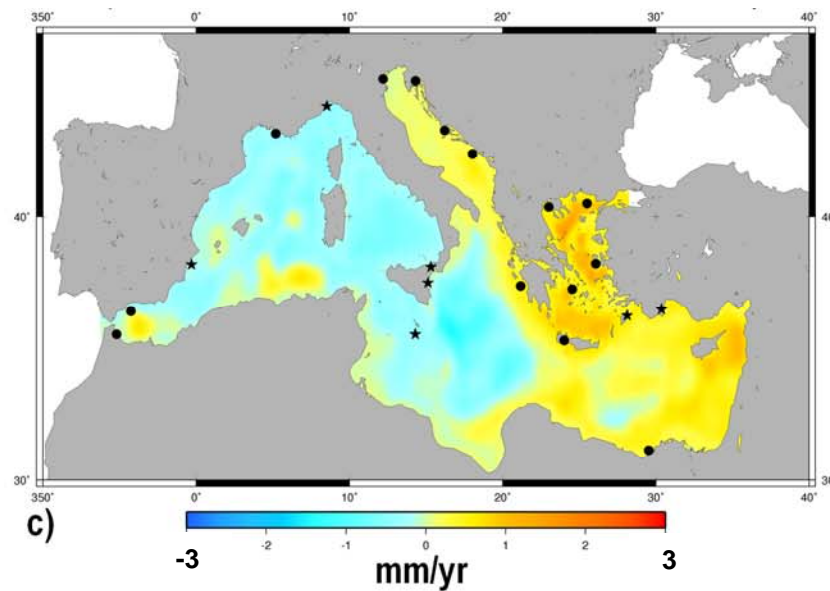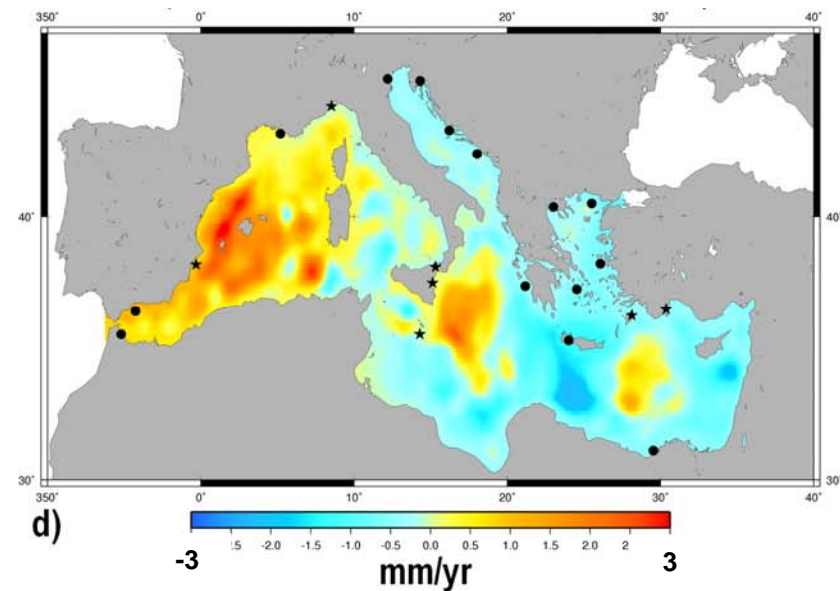
c)

-3 ... **mm/yr** ... **3**

NEMOMED8 reconstruction

d)

-3 ... **mm/yr** ... **3**

The reconstruction that shows the best results over 1970-2006:

NM8 Reconstruction

a) EOF1

b) EOF2

EOF1 of NM8 Reconstruction (Black) and NAO index (Red)
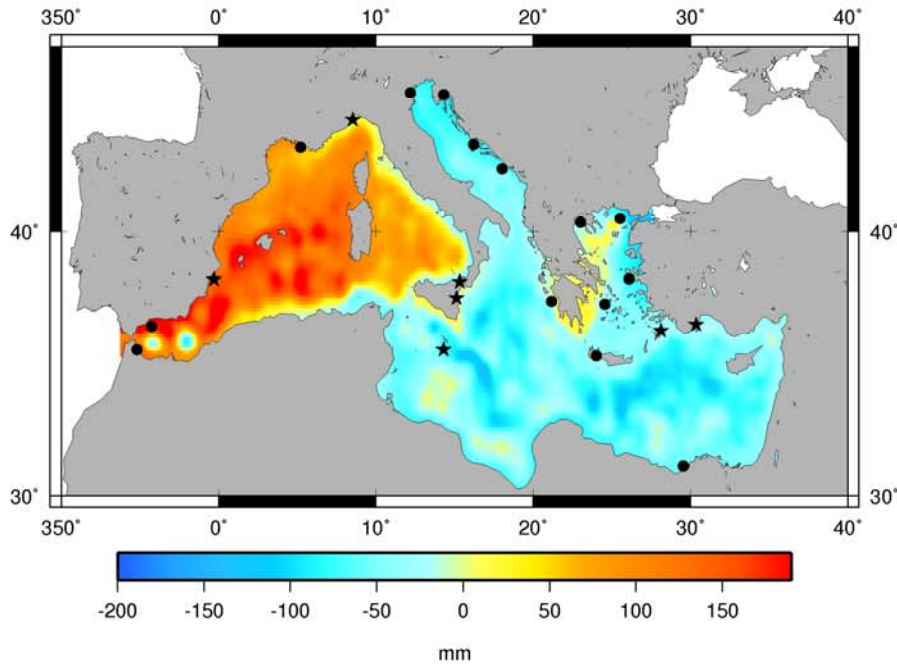
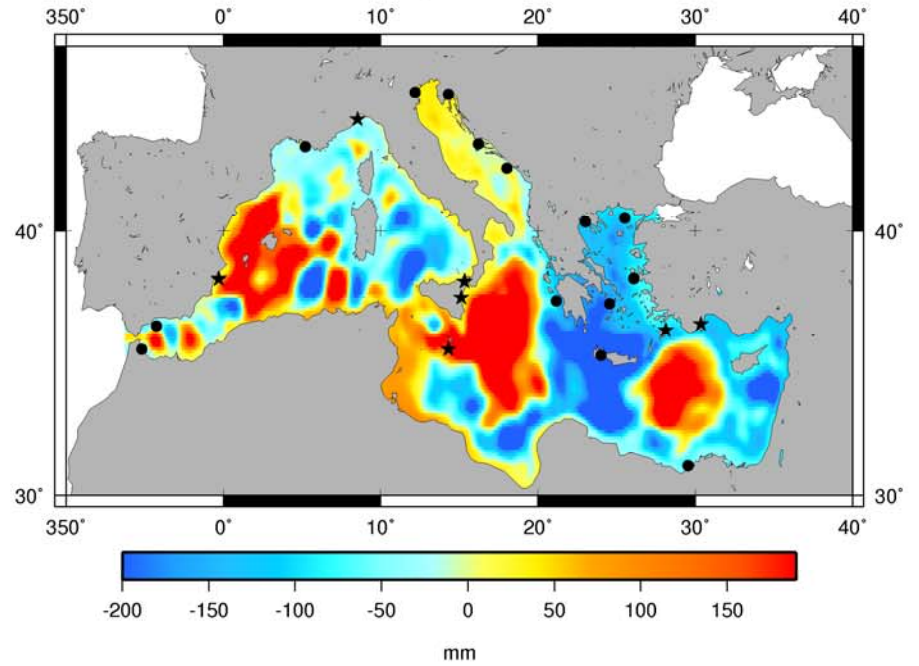-EOF2 of NM8 Reconstruction (Black) and NAO index (Red)

The reconstruction that shows the best results over 1970-2006:

NM8 Reconstruction
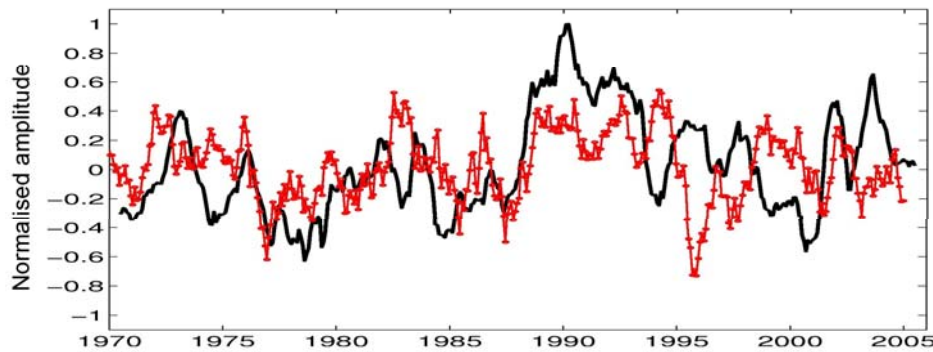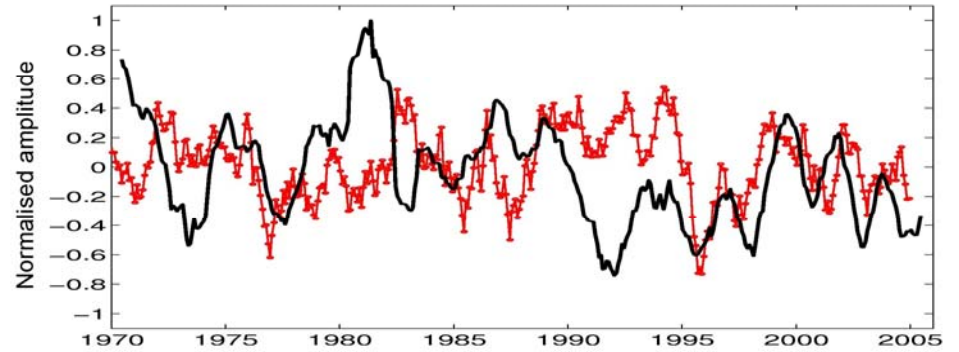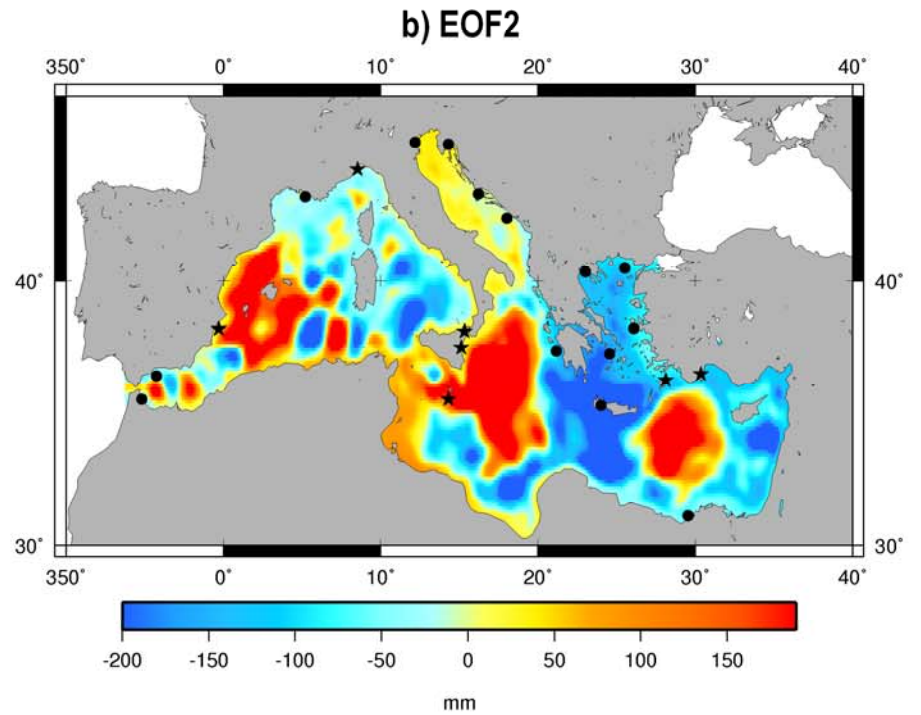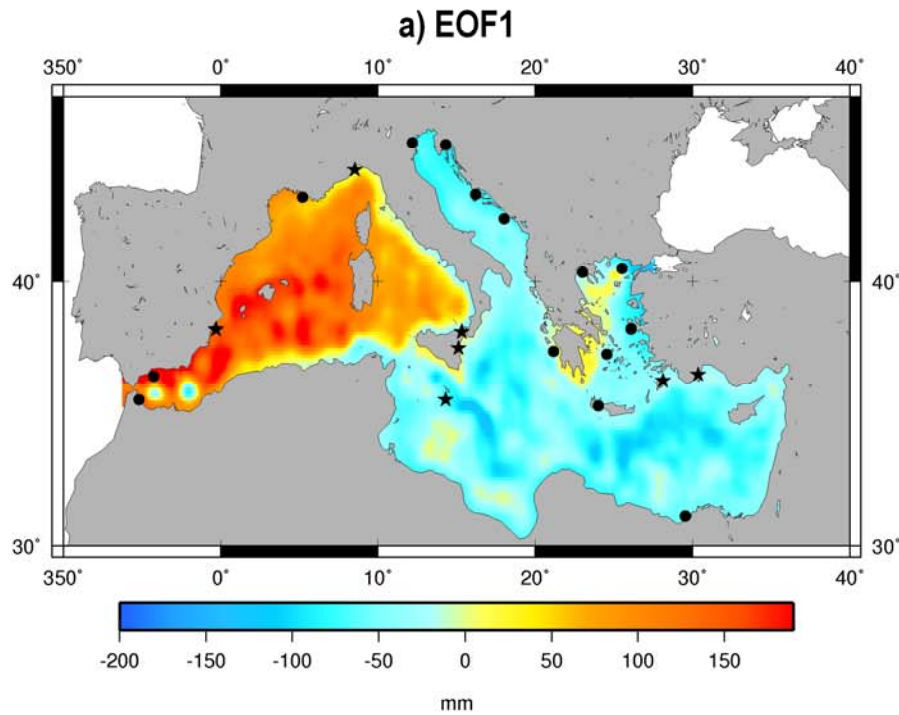
a) EOF1

b) EOF2

EOF1 of NM8 Reconstruction (Black) and NAO index (Red)

-EOF2 of NM8 Reconstruction (Black) and NAO index (Red)

Conclusion

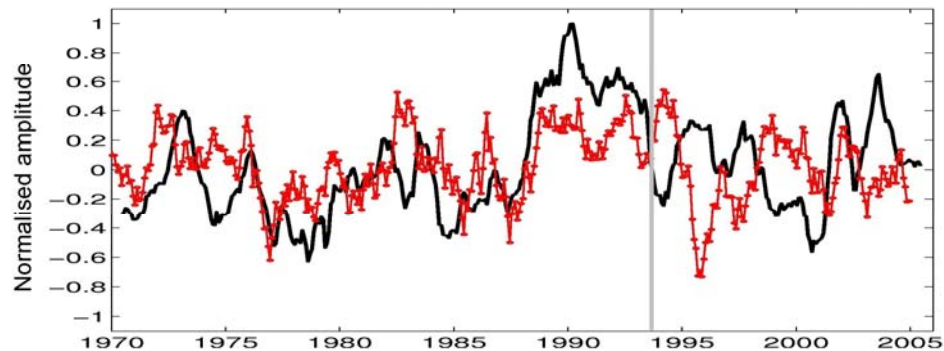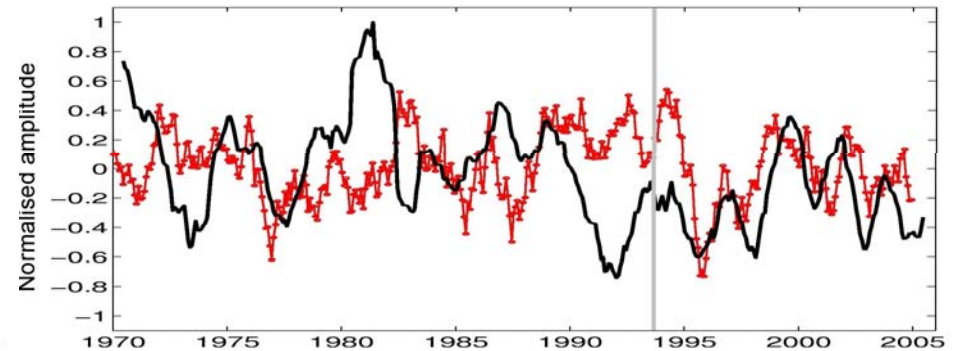• **The regional reconstruction in the Mediterranean Basin is very different from the global reconstructions (Church et al (2004), Llovel et al (2009))**

• **Concerning the reconstructed interannual/decadal variability, reconstructions based on models EOFs (NEMOMED8 and PROTHEUS) and on altimetry show an overall agreement.**

• **At sub-basin scale, the ROM reconstructions (especially the NM8 reconstruction) perform better in the Ionian basin than altimetry-based, and this is probably due to a too strong representation of the EMT event in the altimetry EOFs.**

• **Nevertheless Trends map appear to be still unsignificant. Too many discripancies with TG (too short records wrt the strong Mediterranean sea level interannual variability)**

• **The NM8 reconstruction shows the highest correlation with test tide gauges. It suggest that the NAO forcing has modified its impact on the Mediterranean sea level patterns**

Meyssignac B. Francesc M. C., Somot S., Rupolo V., Stocchi P, Llovel W. Cazenave A., Morrow R., Two-dimensional reconstruction of the Mediterranean sea level over 1970 - 2006 from tide gauge data and regional ocean circulation model outputs. *Ocean Dynamics,* submitted.