

Lake level changes in the Caspian Sea monitored by satellite altimetry and gravimetry

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Caspian Sea



Image credit: University of Texas Libraries

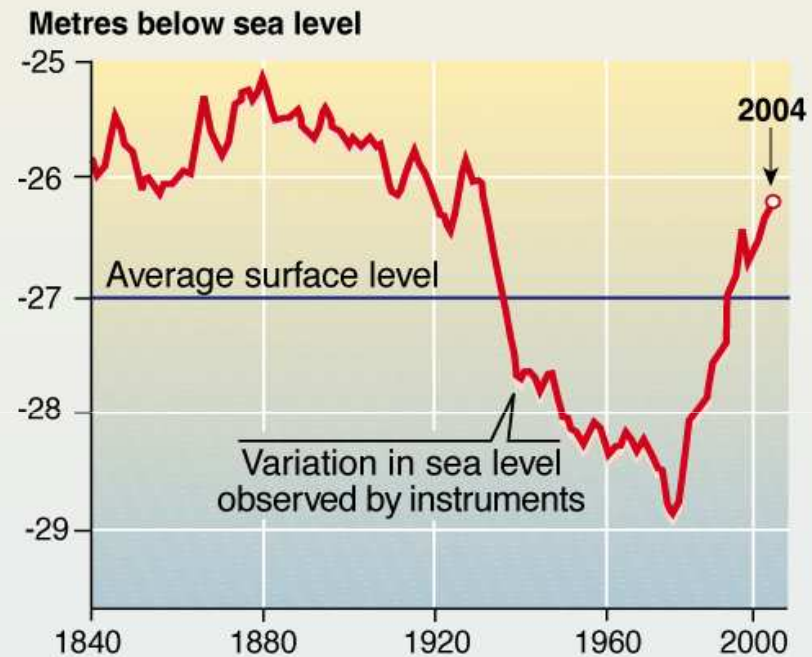
- Largest lake of the world
- Lake level: -27 m
- Volume: 78,200.00 km³
- Surf. Area: 436,000.00 km²
- Mean depth: 187.0 m
- Max depth: 1,025.0 m
- Catchment size: 1,400,000.00 km²
- Salinity: ~12 PSU

Caspian Sea level

Annual discharge into the Caspian Sea



Changing Caspian



Source: Klige, 1992; The Academy of Geography in Azerbaijan.

Images credit: UNEP/GRID-Arendal,
Philippe Rekacewicz

Objectives

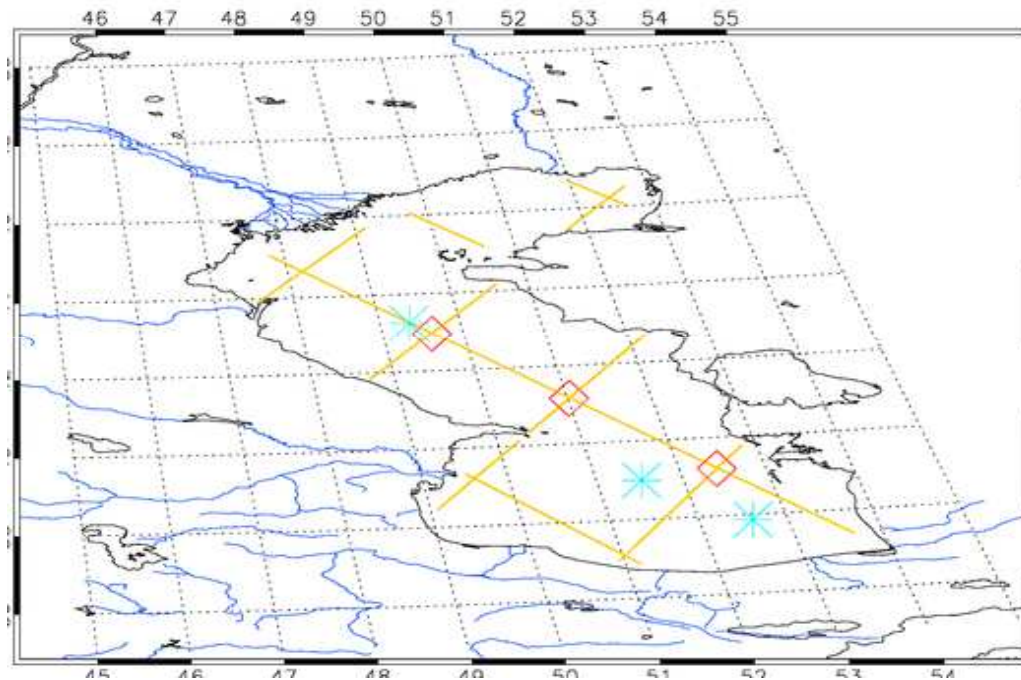


June 4 2010, MODIS (TERRA)

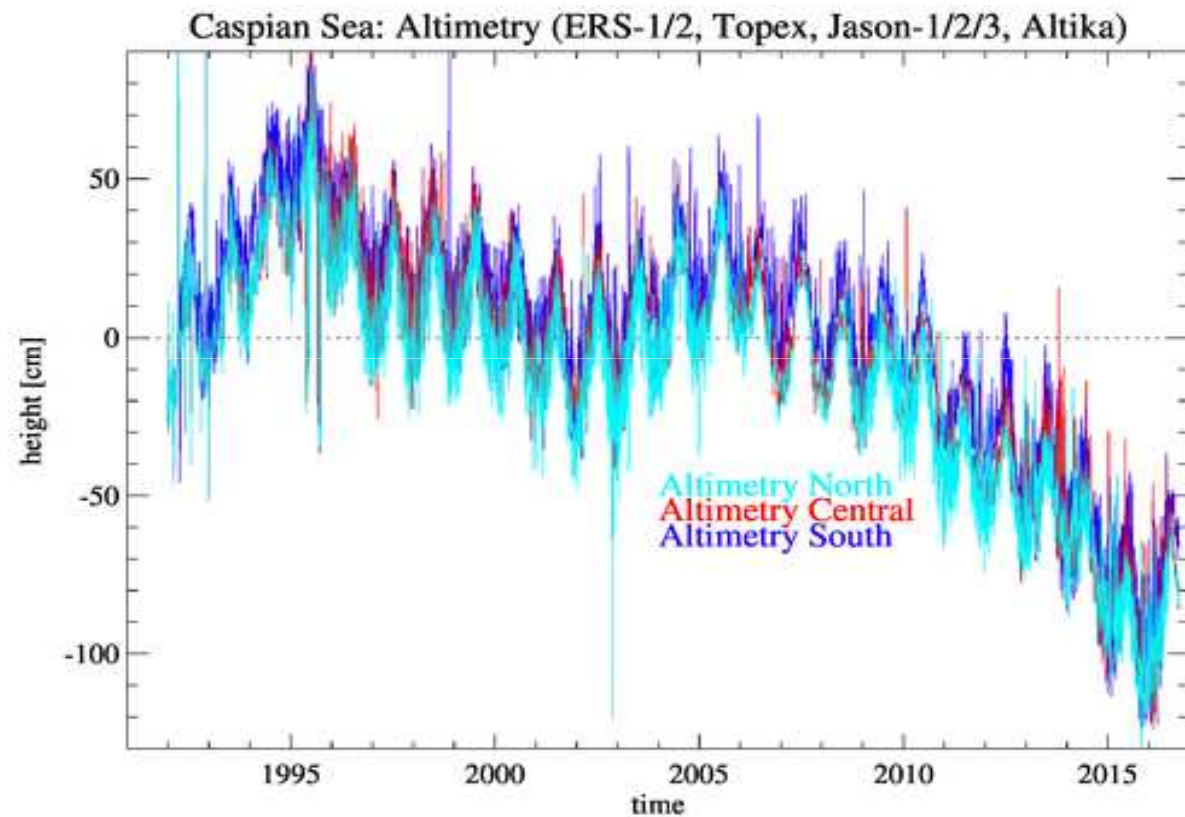
Image credit: NASA image by Jeff Schmaltz,
MODIS Rapid Response Team

- Temporal evolution of mean lake level from altimetry
- Can the associated mass changes be measured by GRACE ?
- Spatial-temporal patterns of lake level variability

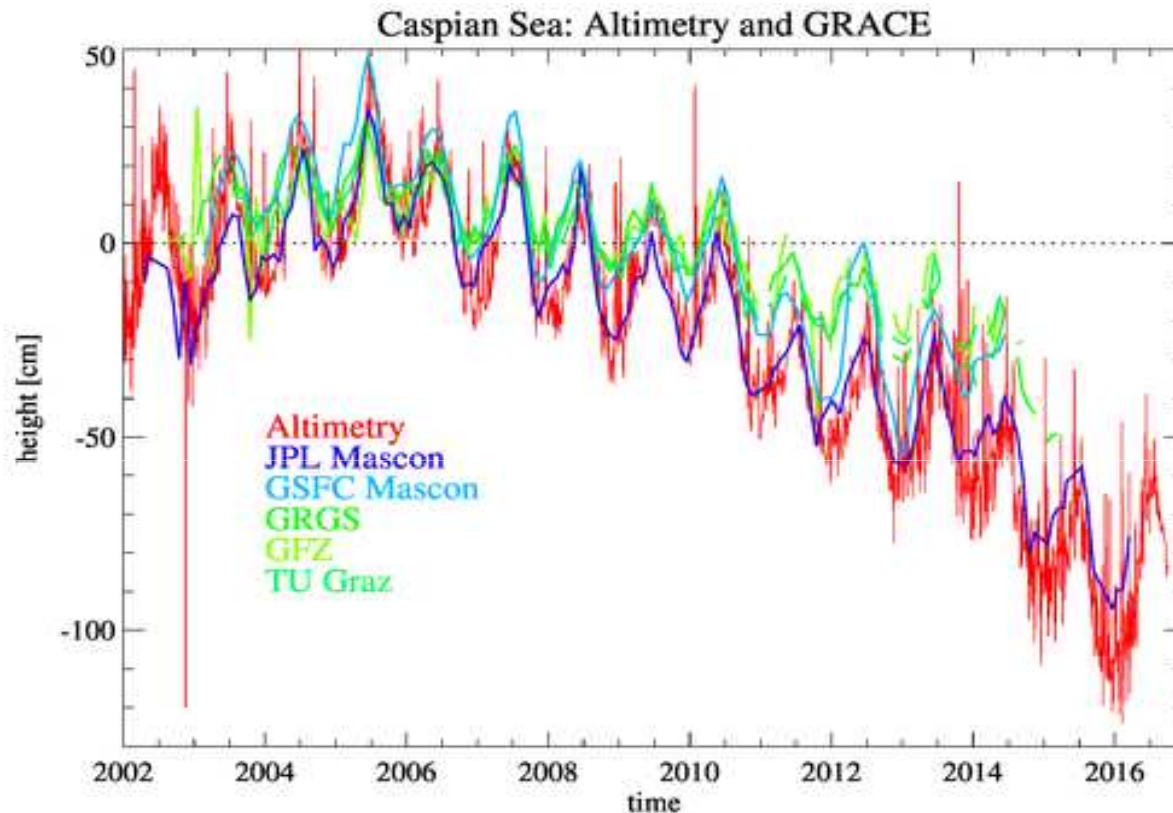
Altimetry: height series from cross-over points



Altimetry: height series from cross-over points



Altimetry and Gravimetry

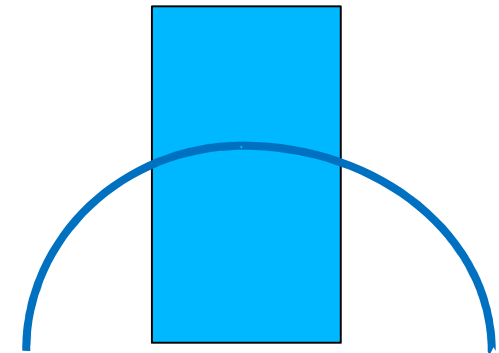
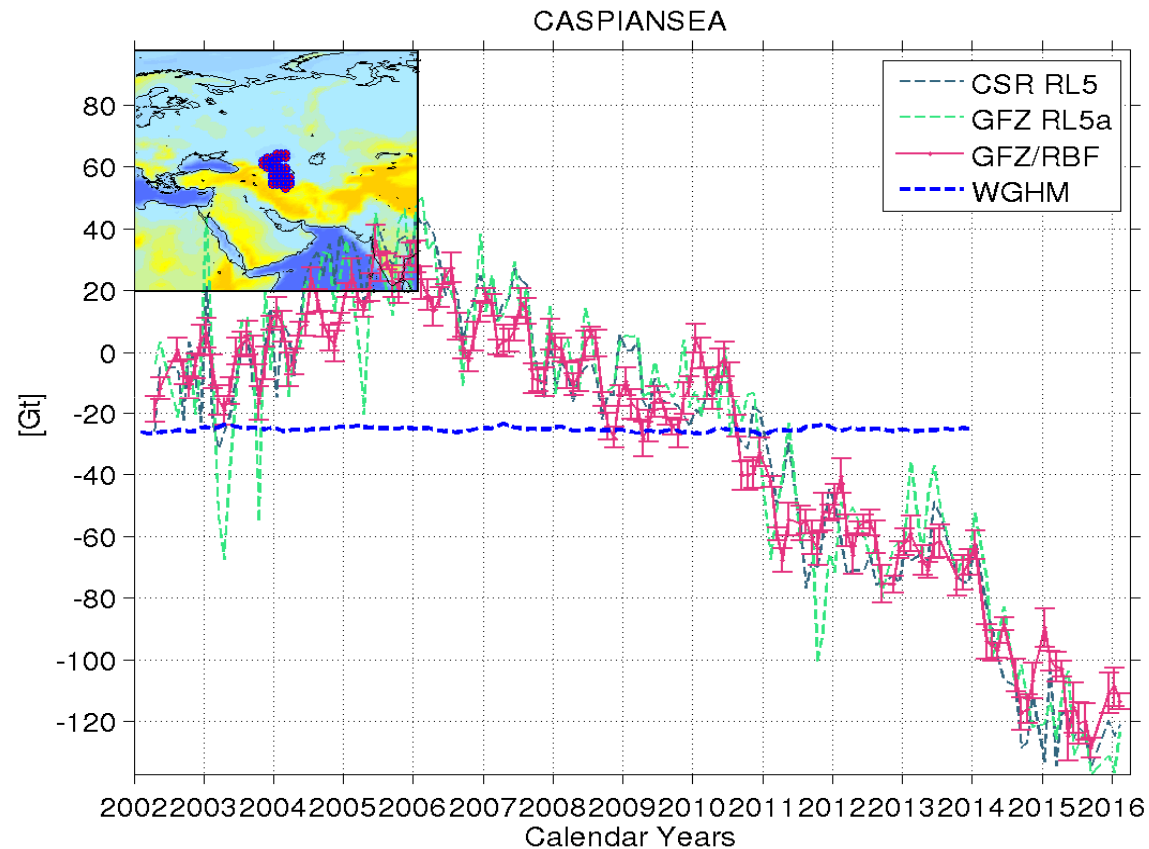


- GFZ, GRGS, TU Graz:
EGSIEM plotter
<http://plot.egsiem.eu/>
- JPL mascons:
http://grace.jpl.nasa.gov/data/get-data/jpl_global_mascons/
- GSFC mascons:
<http://ccar.colorado.edu/grace/gsfsc.html>

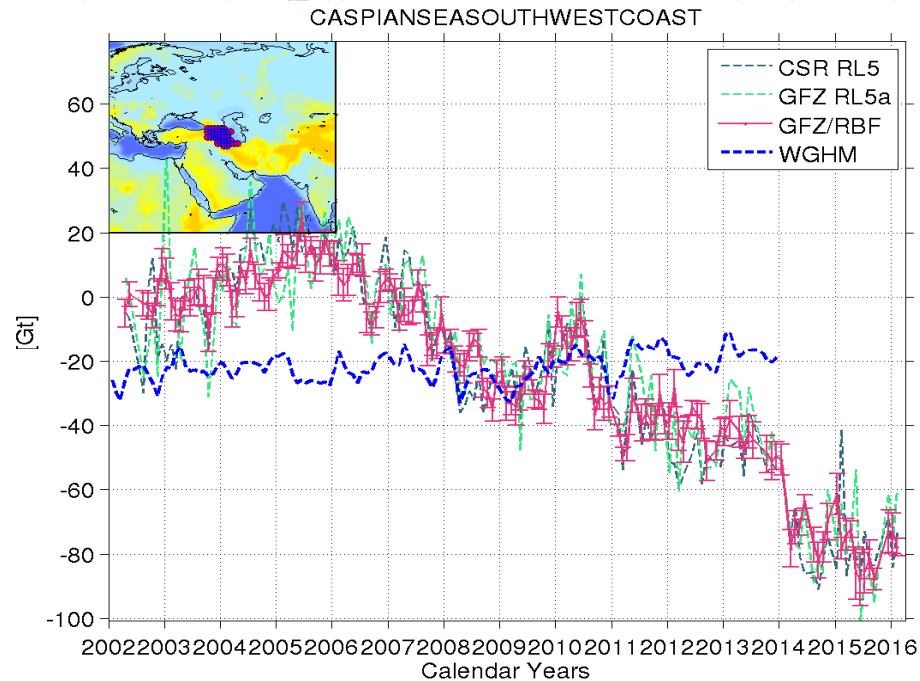
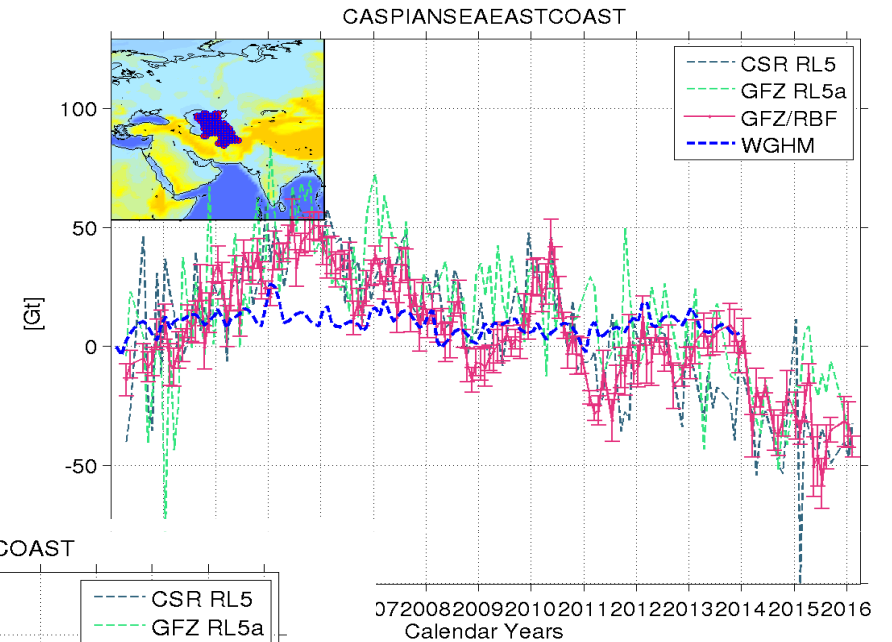
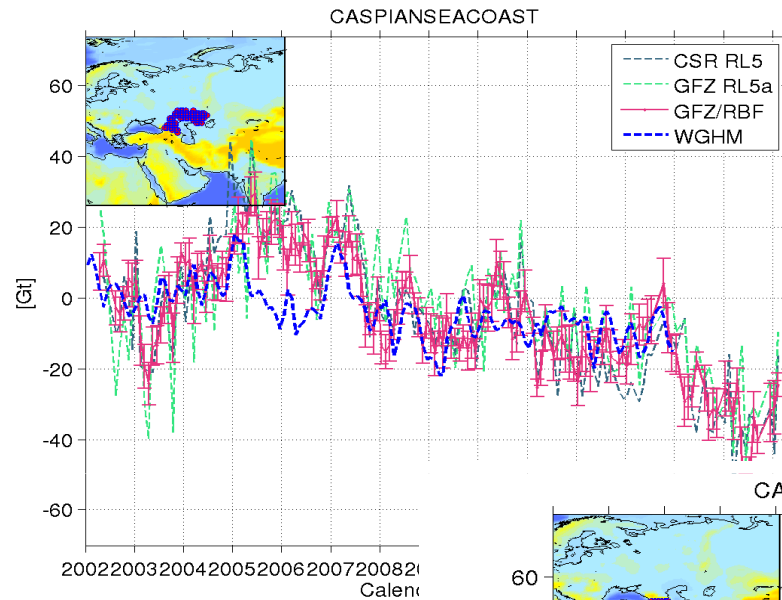
Annual Amplitude and Trend (07/2005-09/2014)

	Altimetry	GRACE	JPL mascon	GSFC mascon
Annual Amplitude [cm]	12 to 14	7 to 10	8 to 11	14
Trend [cm/year]	-8.6 to -9.4	-4.4 to -5.6	-6.1 to -7.9	-6.9

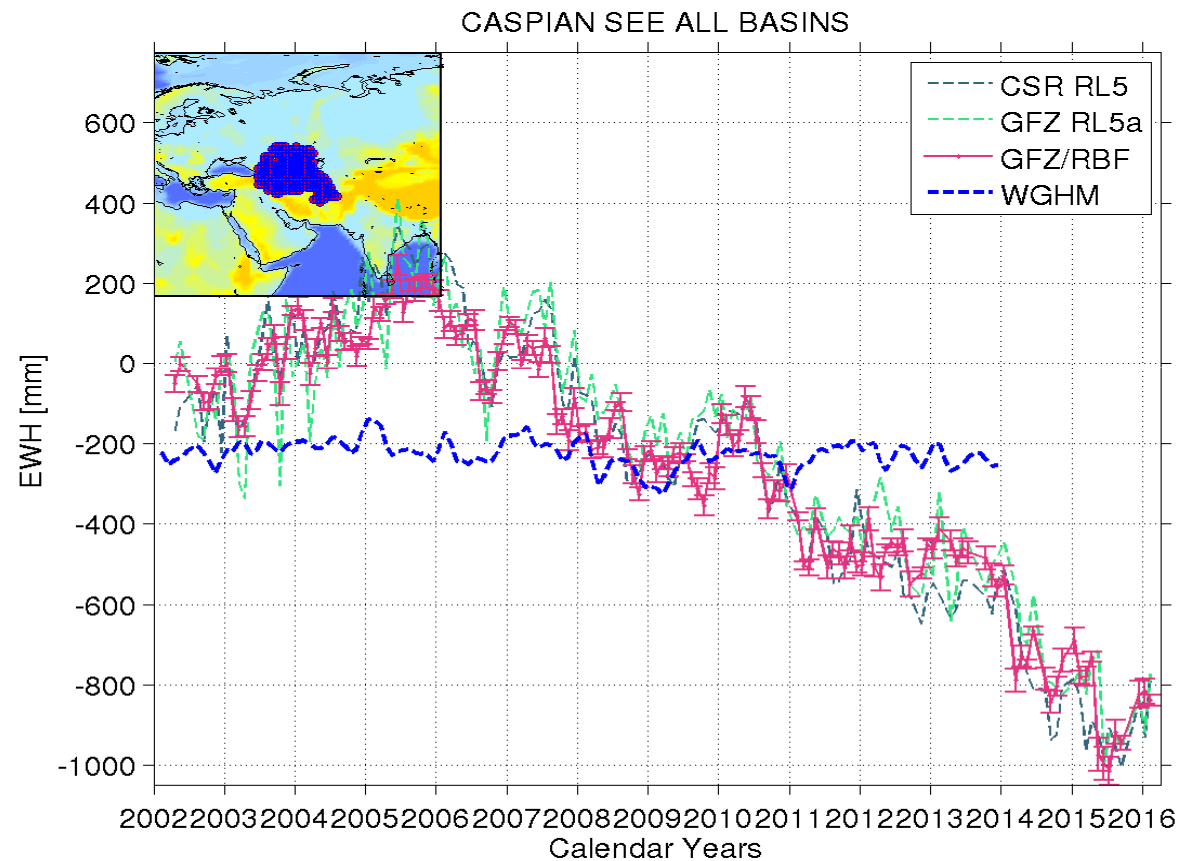
GRACE: Caspian Sea deseasoned [Gt]



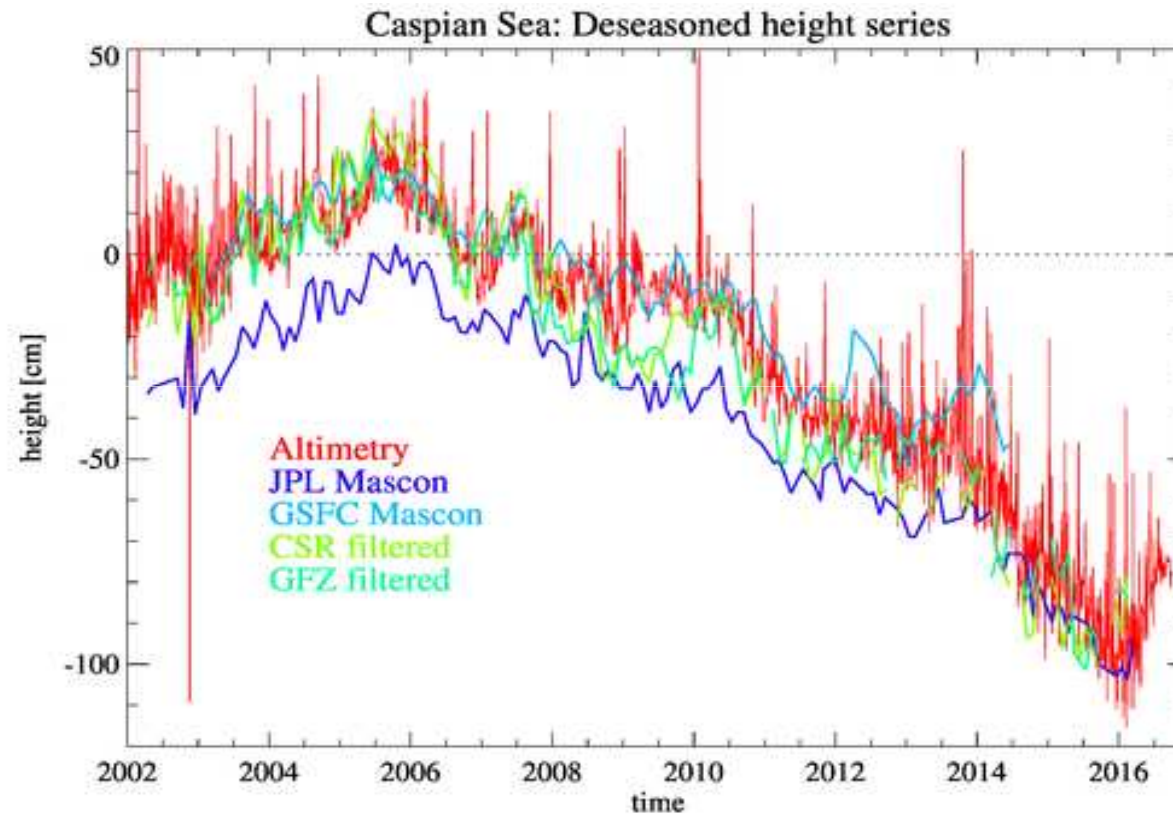
GRACE: Surrounding Coasts



GRACE: Caspian Sea – full deseasoned signal



Altimetry and Gravimetry-deseasoned series



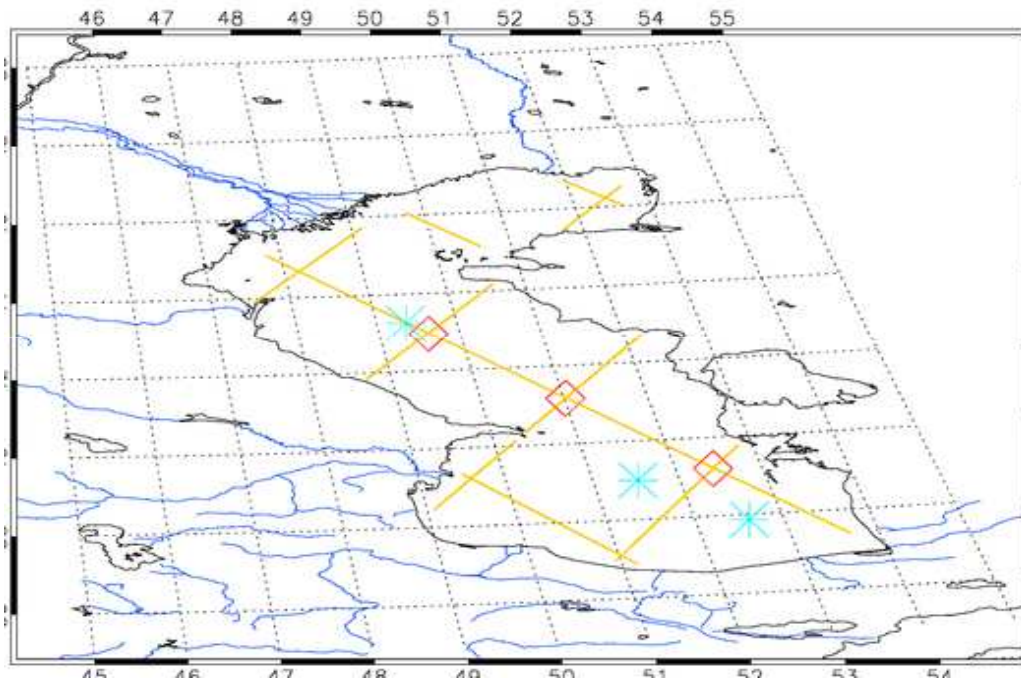
Trend (07/2005-09/2014)

	Altimetry	JPL mascon	GSFC mascon	GRACE GFZ	GRACE CSR
Trend [cm/year]	-8.6 to -9.4	-6.1 to -7.9	-6.9	-9.1	-10.5

Annual Amplitude and Trend (07/2005-09/2014)

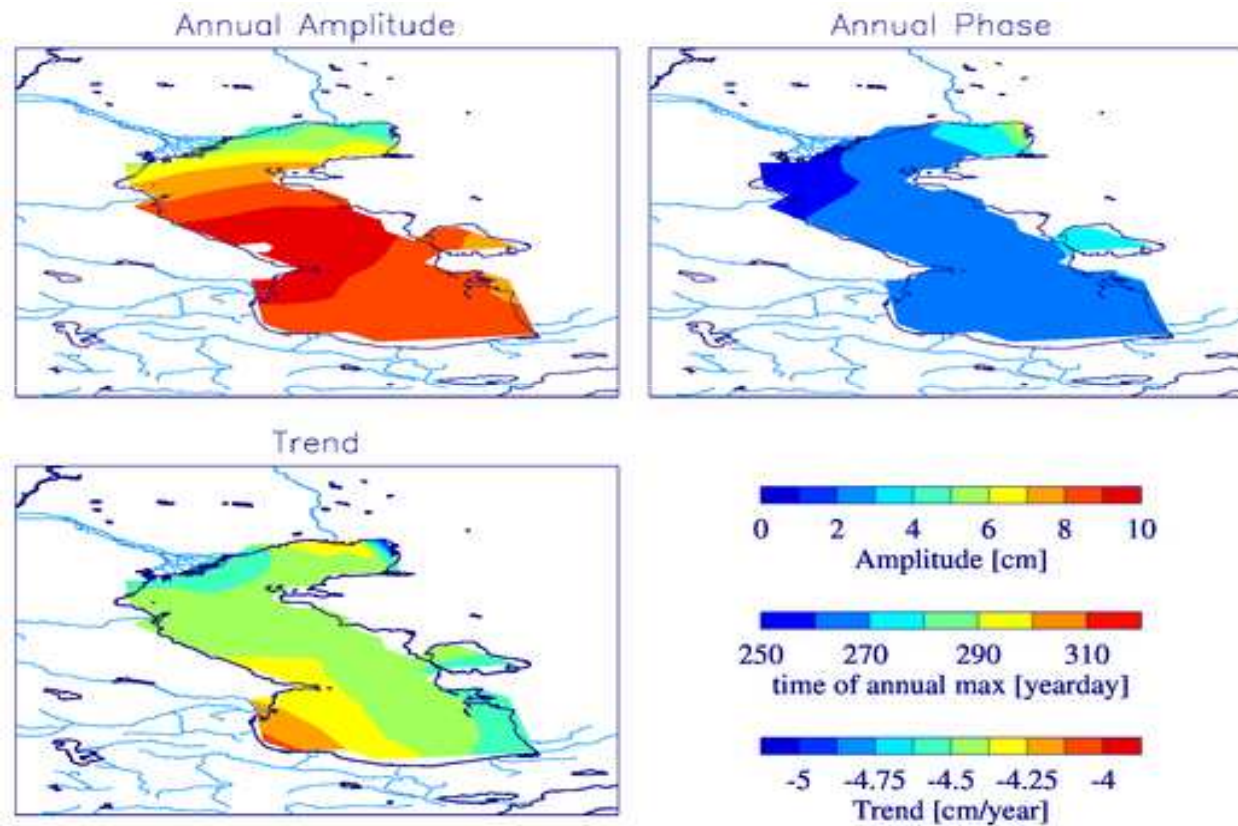
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Altimetry: collinear analysis of Topex/Jason series

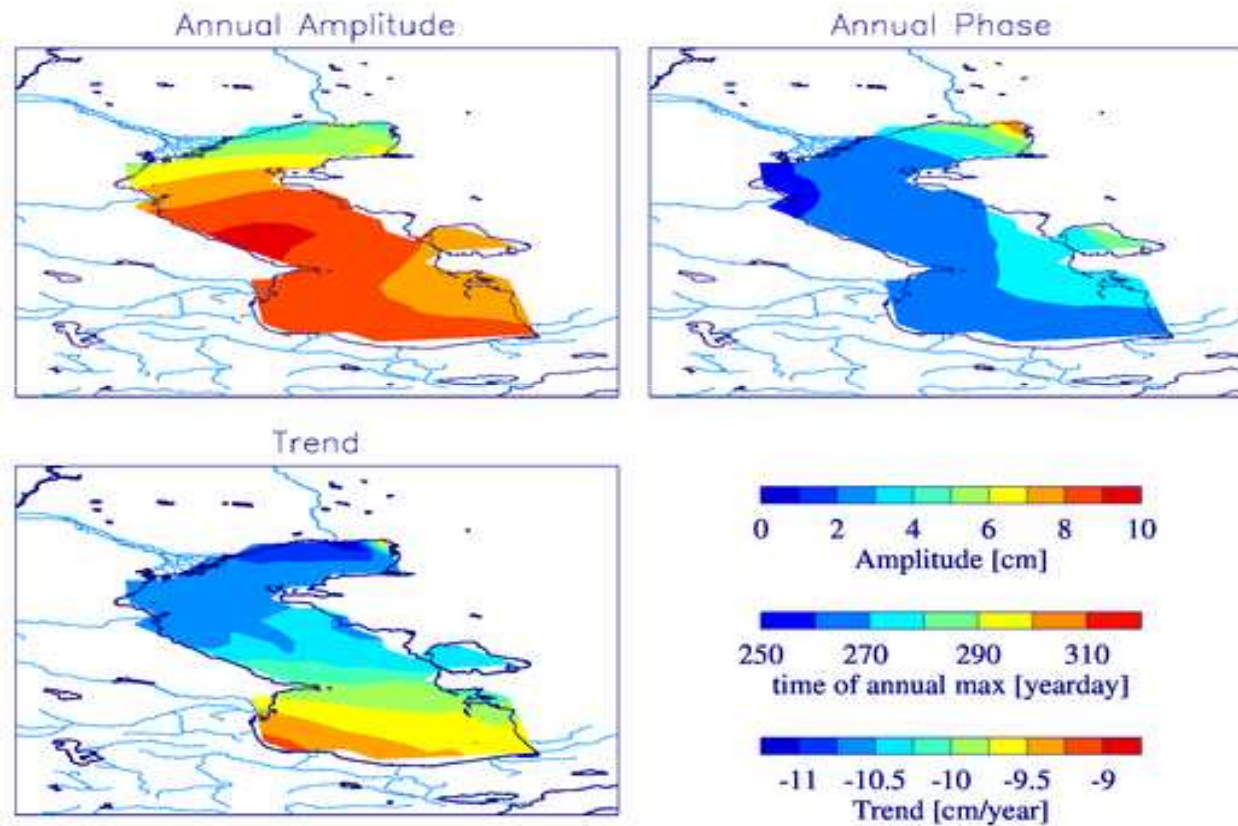


- From 1993 to 2016
- Every 10 days

Annual Amplitude and Trend (04/1993-04/2016)

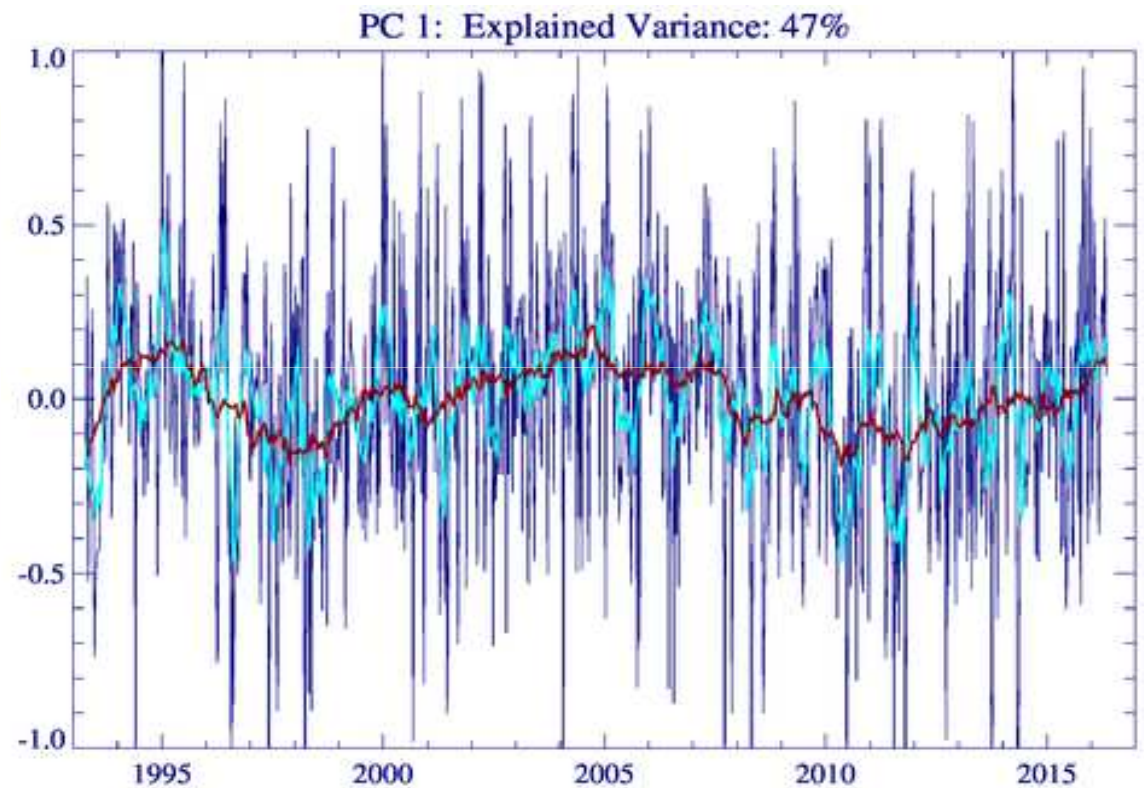
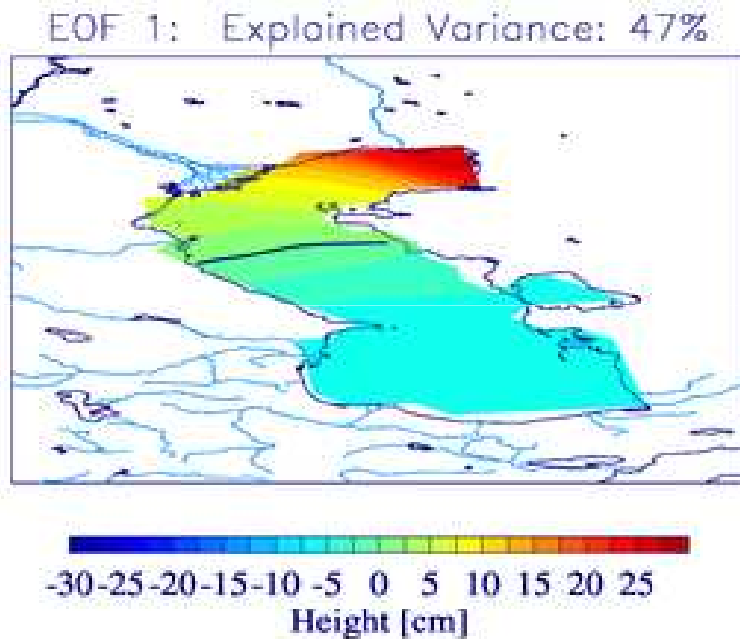


Annual Amplitude and Trend (07/2005-09/2014)



EOF-Analysis - EOF1

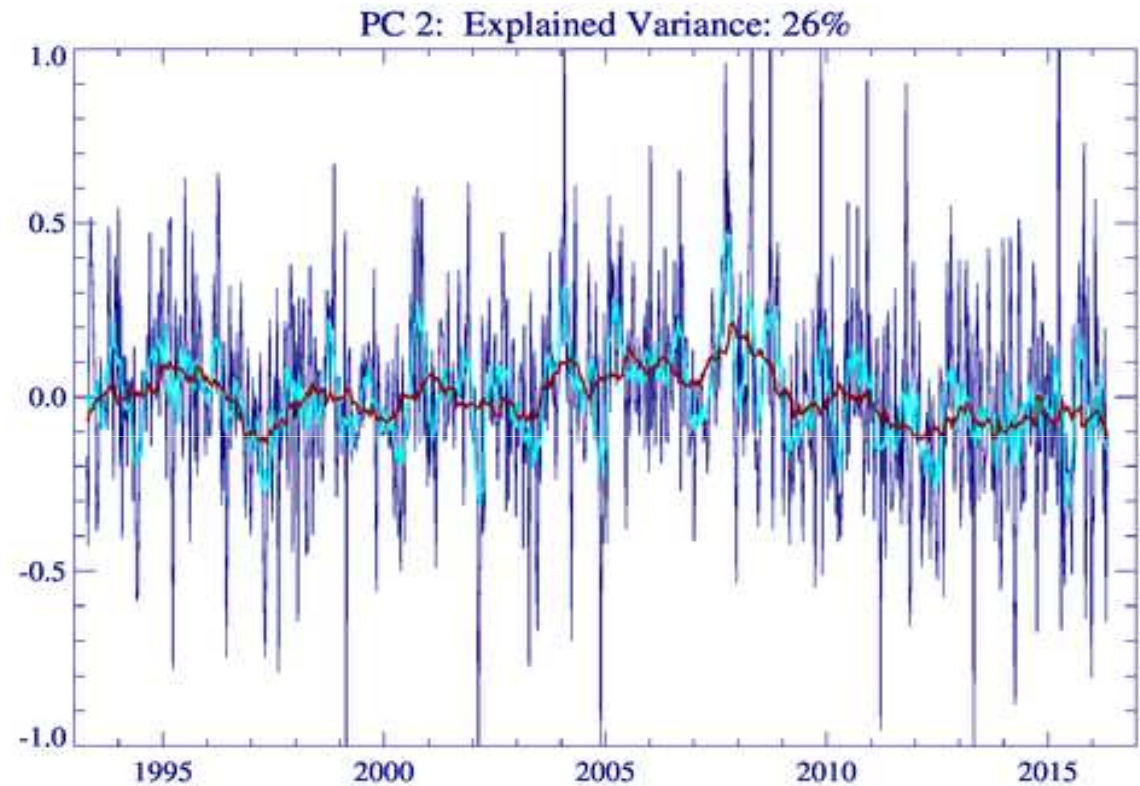
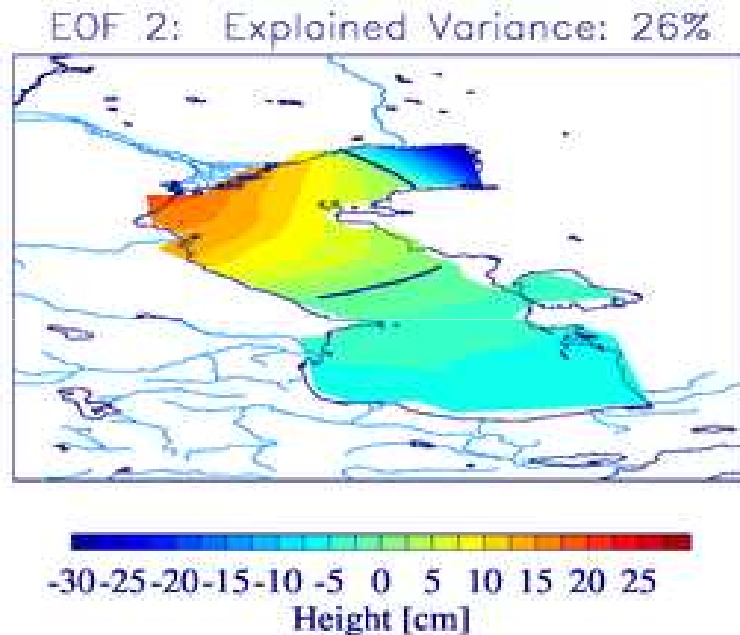
(Mean Caspian sea level subtracted)



Boxcar: 3 months & 1 year

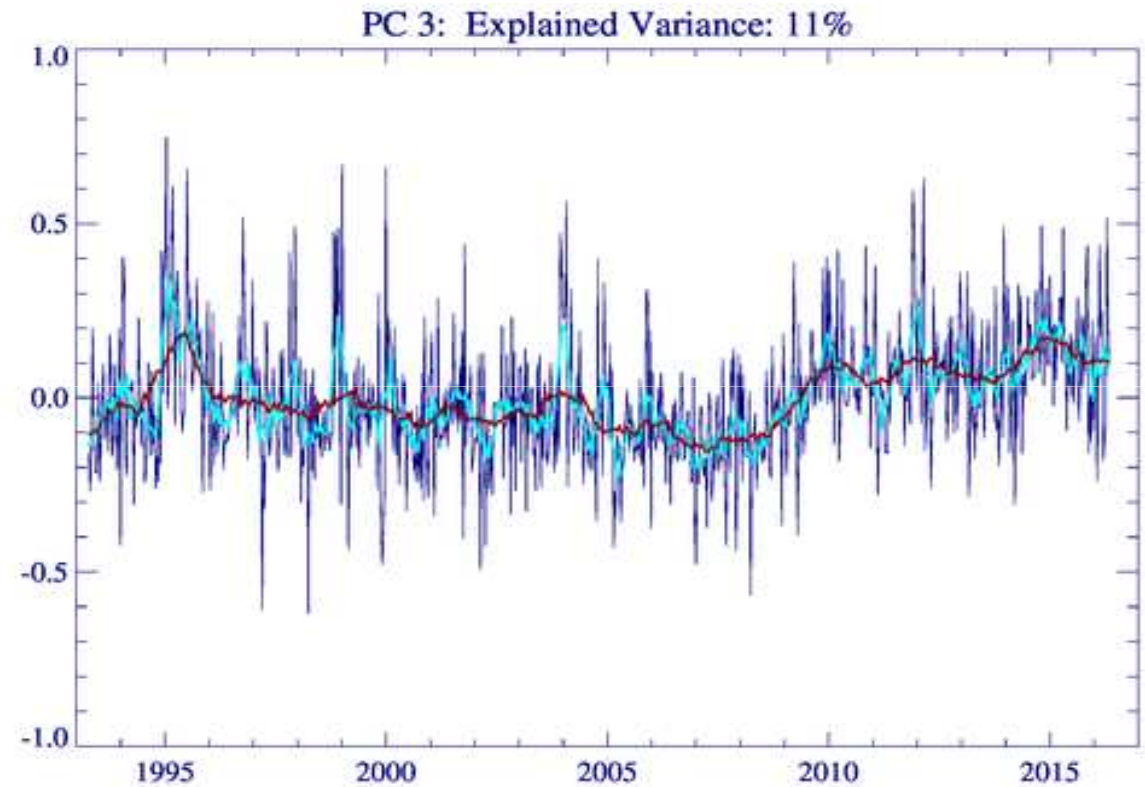
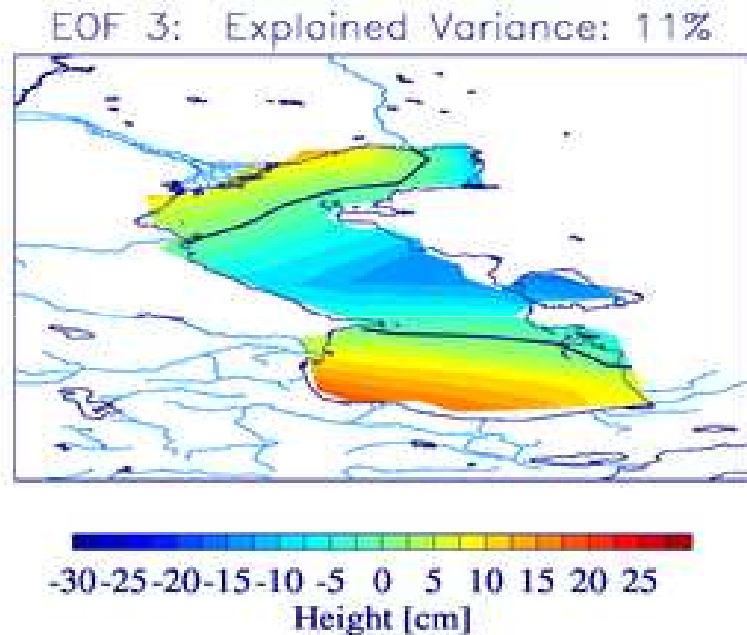
EOF-Analysis – EOF2

(Mean Caspian sea level subtracted)



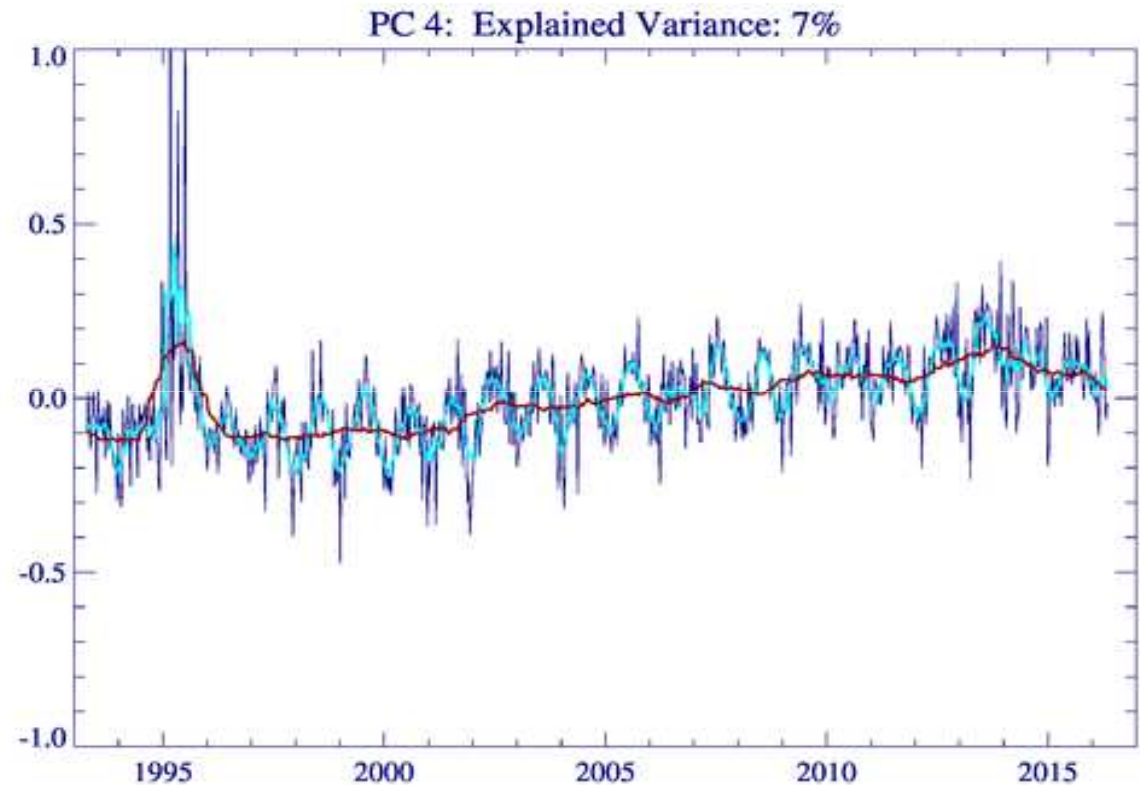
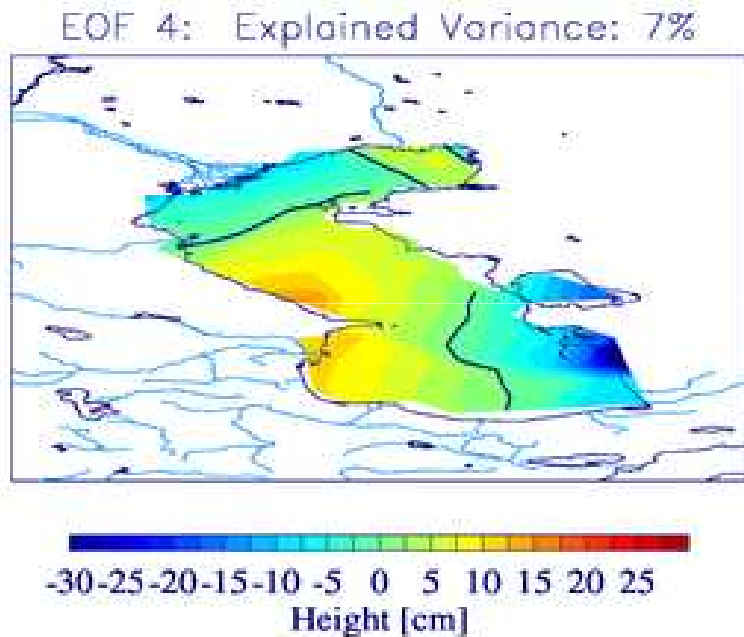
Boxcar: 3 months & 1 year

EOF-Analysis – EOF3 (Mean Caspian sea level subtracted)



Boxcar: 3 months & 1 year

EOF-Analysis – EOF4 (Mean Caspian sea level subtracted)



Boxcar: 3 months & 1 year

Conclusions

- From 2006 to the end of 2015 the Caspian Sea level has fallen by more than 1 m
- There is indication that this trend might have reversed since beginning of this year
- After proper consideration of leakage effects observed sea level and mass changes are in good agreement
- Leakage effects are not only observed for the conventional time variable gravity field solutions but also for the mascon solutions
- trend stronger in the North than in the South

Sea surface salinity

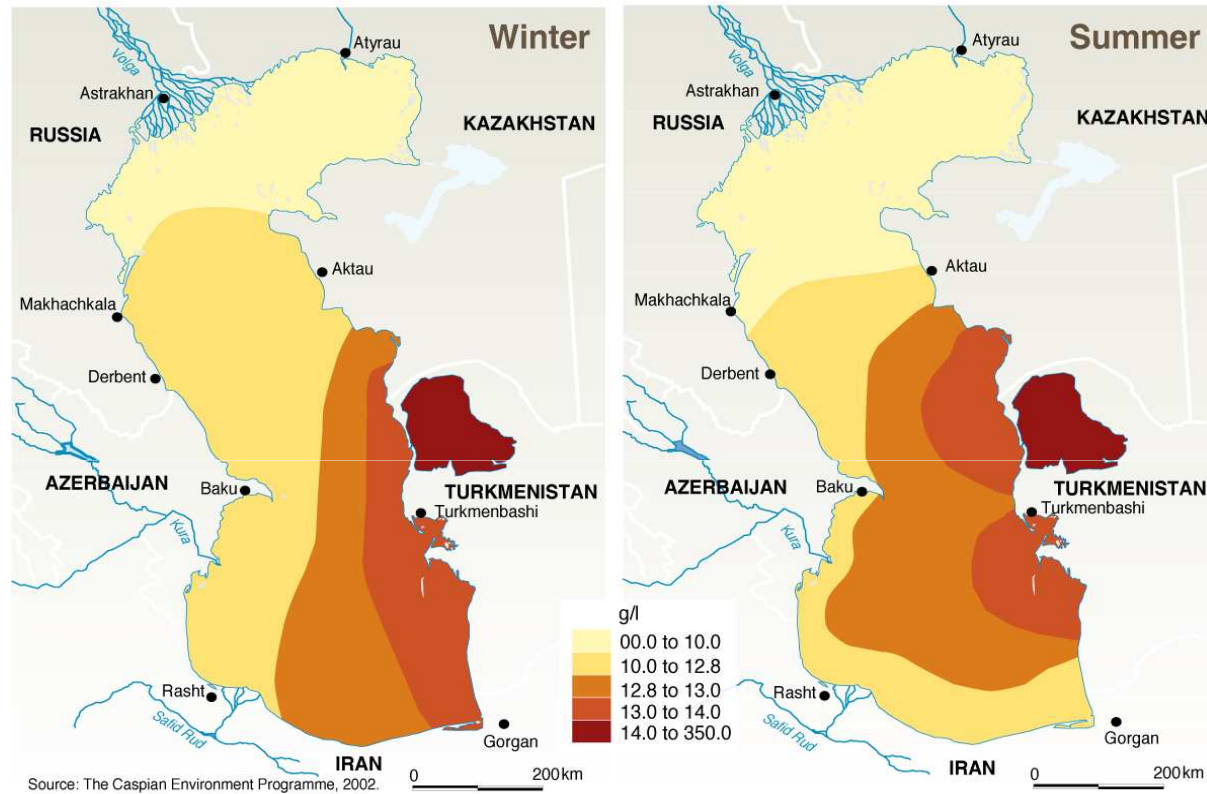


Image credit: Philippe
Rekacewicz, UNEP/GRID-Arendal