

# MASS CONTRIBUTION TO MEDITERRANEAN SEA LEVEL VARIABILITY FOR THE PERIOD 1948-2000

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## Abstract

The mass contribution to Mediterranean Sea level variability is estimated from steric-corrected altimetry and from GRACE observations for the period August 2002 to December 2006. The good agreement between GRACE observations and steric-corrected altimetry supports the quantification of the long-term mass contribution in terms of non-steric sea level in the Mediterranean. For the past decades, total sea level fields are reconstructed using a reduced-space optimal interpolation of altimetry and tide gauge data. The steric component is evaluated from hydrographic observations available for the same period. Results indicate that the mass content has increased at a rate of  $0.8 \pm 0.2$  mm/yr for the period 1948-2000. When the effect of the atmospheric pressure is removed, the trend of the mass component is  $1.2 \pm 0.3$  mm/yr.

*Keywords: Sea Level, Geophysics, Global Change*

## Introduction

In this paper we first use altimetry, GRACE and hydrographic observations spanning the period 2002-2006 to assess the consistency between total sea level and its two components (steric and mass) in the Mediterranean Sea. Fenoglio-Marc et al. [1] and García et al. [2] carried out similar works for the period 2002-2004, but they only focused on the seasonal sea level cycle. Here we consider both intra and inter-annual variability. Other differences with respect to those works are that they use model data (not hydrographic observations) to estimate the steric cycle and that an improved and longer GRACE data set has been made available since then. The good agreement found between GRACE observations and steric-corrected altimetry supports the quantification of the mass contribution in terms of the non-steric sea level in the Mediterranean. Hence, we also evaluate the mass contribution to sea level for the period 1948-2000.

## Data sets

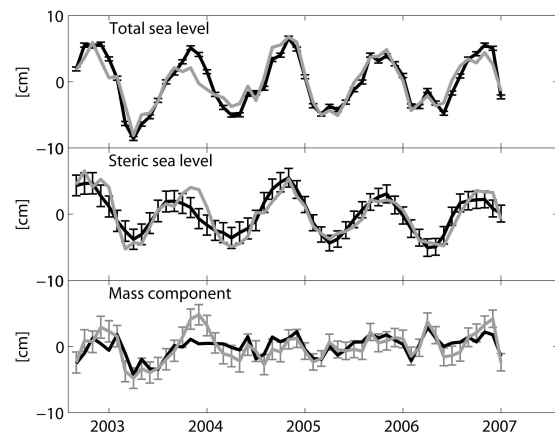
The Level-2 Release-04 (RL04) gravity coefficients computed at the Center for Space Research (CSR) and distributed by the GRACE project are used to estimate water mass variations in the Mediterranean Sea between August 2002 and December 2006. A hydrological model is used to correct the effect of land waters. The post glacial rebound correction is also applied. To obtain the basin average a smooth averaging kernel is used.

For the period 2002-2006 the Mediterranean mean sea level is computed from Altimetry data while for the period 1948-2000 total sea level fields are reconstructed using a reduced-space optimal interpolation of altimetry and tide gauge data [3]. The steric component is evaluated from hydrographic observations [4]. The errors associated with total sea level and the steric component are evaluated in order to obtain the uncertainty of non-steric sea level.

## Results and discussion

Consistency between non-steric sea level and GRACE observations is found for the period August 2002 to December 2006 (Fig.1). The observed mass component from GRACE and the estimated contribution from non-steric sea level have a correlation of 0.75 (significant at the 95% confidence level). The existence of a seasonal cycle in the mass component of Mediterranean mean sea level is not evident and, if it exists, it is not the most energetic signal. The linear trend of the steric-corrected altimetry and that obtained from GRACE are fully consistent: their values are  $2.1 \pm 0.6$  mm/yr and  $2.1 \pm 0.5$  mm/yr, respectively.

The consistency between non-steric sea level and GRACE observations supports that the mass component can be obtained as the non-steric contribution of Mediterranean sea level for a longer period. The overall trends computed for the period 1948-2000 are  $-0.25 \pm 0.04$  mm/yr for the steric component and  $0.96 \pm 0.05$  mm/yr for the atmospherically-corrected total sea level. The net mass contribution to sea level trends would then be of the order  $1.2 \pm 0.3$  mm/yr. When the atmospheric component is included the mass component shows a smaller trend:  $0.8 \pm 0.1$  mm/yr. Those values are in agreement with the global mean value obtained by Domingues et al. [5] for the period 1961-2003 (between 0.8 and 1.1 mm/yr).



**Fig. 1. Mediterranean mean sea level variability and its components with error bars for the period August 2002 to December 2006: (atmospherically-corrected) total sea level (top), the steric component of mean sea level (middle), and the mass component of sea level (bottom). Black lines show the observed estimates from satellite altimetry (top), the Ishii dataset (middle) and GRACE (bottom), respectively. Grey lines show the estimates obtained by adding or subtracting the other two observational components.**

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