COMPARISON OF SEA LEVEL CHANGES IN THE LAST DECADE IN THE MEDITERRANEAN SEA USING SATELLITE ALTIMETRY VS TIDE GAUGE DATA

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Abstract

Sea level change has been measured over the last ten years using both tide gauge and altimetry. Only decadal and higher frequency sea level changes are studied using altimetry, due to its shorter time interval of data availability, while the lower frequency variations are investigated using tide gauge data. Altimetry from the Topex Poseidon mission and tide gauge time-series are compared in the time and frequency domains at a number of stations in the Mediterranean Sea. A good agreement is found between the decadal, the interannual and the seasonal components of the variability and three regions with different characteristics are identified in the Mediterranean. Linear trend of the sea level height differences of monthly and instantaneous sea level heights are interpreted as potential vertical land movements.

Keywords: sea level change, tide gauge, altimetry

Introduction

Global coverage and sea level measurements in a given reference frame are characteristics that distinguish altimetry from tide gauge measurements. For altimetry the sampling is denser in space but less dense in time at a given location and the available data span is shorter than for tide gauges. Topex-Poseidon (T/P) data are available since September 1992 with a 10-day time sampling rate, and 300 km spacing at the equator. Long-term sea level changes have been mainly investigated using T/P data [1] and ERS data [2]. The multi-mission altimetry requires a careful cross-calibration of the missions and homogenization of the corrections [3]. At present T/P provides the longest and uninterrupted dataset. Interannual to decadal sea level variations are estimated in the Mediterranean Sea over the interval from September 1992 to July 2002 from T/P altimetry data and from tide gauge monthly averaged data. At a few locations where hourly data are available, sea level heights at the times of the closest approach with the tide gauge sites are also compared and a linear trend in the differences is estimated.

Annual to decadal variations

The sea level anomalies are averaged in monthly grids with spacing of 1 x 1 degree using a Gaussian weighted average method with the half-weight parameter equal to 1 and the earth radius equal to 3 degrees. The inverse barometric correction is not applied to the altimetry data, while ocean, load and earth tide are applied. For each time-series in the grid nodes, the linear-term (decadal variability), the average variability over each month (seasonal variability) and the interannual components of the variability contained in the power-spectrum of the residuals are estimated. The decadal term is small in the western Mediterranean (a few mm/yr) and higher with positive values in the eastern Mediterranean (up to 8 mm/yr) and with negative values in the Ionian Sea (up to –12 mm/yr). The decadal component of sea level variability has a high correlation with decadal components of sea surface temperature and steric height change. The dominant frequency of the interannual part of the variability is different in the eastern and in the western Mediterranean. The comparison between the altimetry and the tide gauge results shows a good agreement between the decadal component of the sea level variability, while the cross-spectrum of the interannual variability shows a better agreement in the eastern than in the western Mediterranean.

Linear variability of altimetry *versus* tide gauge data

By differencing records from altimetry and tide gauge data, most of the coherent sea level variability is removed and the residual time series represents the Vertical Land Motion (VLM) at the tide gauge site together with any instrumental errors, such as datum shifts and data spikes in the tide gauge data and bias and drift in the altimeter data. By differencing records from adjacent stations, the differential VLM of the stations and the differential sea level variability is obtained. Differences between tide gauge sea level heights and altimetry derived sea level heights are computed separately using monthly averaged values and interpolated hourly averaged tide gauge data versus instantaneous altimeter sea level data at the time of the closest altimeter approach. In this last case, the ocean tide correction was not applied to the altimetry data, therefore the differential sea level variability due to currents and tides remains in the difference. The results are represented in Figure 1 for the stations of Toulon (SIMN) in the western Mediterranean and of Hadera (MedGLOSS) in the eastern Mediterranean. The linear-term of the sea level height differences is here of main interest. The small standard deviation of the differences and the high correlation coefficient show a good agreement of the data. The sea level height differences are used to assess the data quality and to estimate relative biases and drifts between the altimeter instruments as well as vertical land movements. A bias estimation of each altimeter mission relative to the geocenter requires collocated GPS measurements at the tide gauge station.

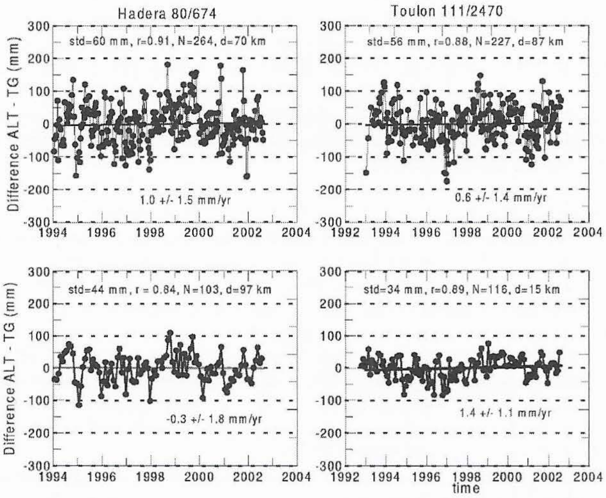

Fig. 1. Sea level height differences of hourly (above) and monthly (below) sea level heights at the tide gauge stations of Hadera and Toulon.

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