SEA LEVEL TRENDS ALONG THE WESTERN COASTS OF ANATOLIA FROM TIDE GAUGE, SATELLITE ALTIMETRY, GPS AND LEVELLING DATA

Hasan YILDIZ, Metin SIMAV, Erding SİZEK, Ayhan ÇINGÖZ, and Ali KILIÇOĞLU

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1. INTRODUCTION

Recently released IPCC’s Fourth Assessment Report (AR4) estimated that sea level will rise 18 to 59 cm with 90% confidence limits during the period 2006-2090. Rahmstorf (2006) developed a simple statistical model that related 20th century surface temperature change to 20th century sea-level change. Using this relationship and projected surface temperature increases, estimated 21st century sea level rise might exceed the IPCC projections and be as large as 1.4 m.

Therefore, studies concerning the determination of the rate of sea level changes at global, regional, and local scales as well as the physical factors that contribute to the observed variability of sea levels have increased greatly than ever before, since they may have strong impacts on coastal ecosystems and human societies.

2. DATA USED

2.1. TIDE GAUGE DATA

The method proposed by Taupin and Spencer (1997) is adopted to determine the amplitudes and the phases of the seasonal sea level cycles. Sea level anomalies are calculated for each month on the basis of complete years only.

2.2. GPS DATA

The method proposed by Aslan and Altunkaynak (2000) is used to obtain amplitude/frequency spectrum of monthly sea level time series. As an example, MC-CLEAN frequency spectrums of Antalya-I tide gauge obtained from input time series after bootstrapping the signal to 50% of its original length and performing a simulation consisting of 1000 iterations is shown below.

3. SEASONAL, INTERANNUAL AND INTERDECADAL PERIODIC VARIATIONS IN TIDE GAUGE’S SEA LEVEL TIME SERIES

3.1. The periods (yr) and mean amplitudes (mm) of main spectral components significant at the 95% level are given in Table 1.

4. SEA LEVEL & TEMPERATURE TRENDS

4.1. Vertical land movements (VLM) at tide gauge locations

In this study, first we investigate sea level trends at the Eastern Mediterranean, Aegean and the Sea of Marmara Coasts of Anatolia derived from five coastal tide gauges which span at least 20 years of data and satellite altimetry observations. Data sets of pressure, air/sea water temperature data recorded at the nearest meteorological stations to the tide gauges are used to determine the possible trend between the mean sea level trends with the local meteorological variations. Second we estimated the VLM at tide gauge by using episodic GPS. Continuous GPS and precise levelling data and compared results with the ICE-5G (VM2) GIA model (Peltier, 2004).

5. VERTICAL LAND MOVEMENTS (VLM) AT TIDE GAUGES

5.1. GPS data used in this study are processed by using GAMIT/GLOBK (V10.21) software (Ring and Bock, 2003). IGS precise ephemeris and Bulletin B values as earth rotation parameters were included in the IGS processing. Processing with 13 IGS stations around Turkey, a series of loosely constrained daily GPS network solutions are obtained for episodic GPS and CGPS sites. Loosely constrained daily GPS solutions, SOPAC coordinate time series, including all IGS stations coordinates in the world, orbit parameters and variance-covariance matrix are directly combined. Combined solutions are then transformed into coordinate time series by using 3-D seven-parameter similarity transformation and stations whose coordinates are defined in ITRF-2000.

6. CONCLUSIONS

6.1. Only at Menteş (MNTS) TG-CPGS station a statistically significant (at 95% confidence level) vertical velocity is found which has a rate of -2.98 ± 0.78 mm/yr. Significant differences between the VLM estimated from GPS, CGPS and precise leveling data and predicted ones from ICE-5G (VM2) GIA model are found.

7. REFERENCES

Hasan Yildiz, Metin Simav, Erding Sizek, Ayhan Cingoz, Ali Kilicoglu. Historical tide gauge measurements from all over the world are the primary source of information to investigate the changes in sea level that have occurred over the last century. However, sea level estimates from individual tide gauges are a combination of any true sea level variations and any vertical land movements (VLM). Although, it is possible to make this correction based on glacial isostatic adjustment (GIA) models which do not explain all of the VLM occurring at all of the tide-gauges in the world (Teferle et al., 2006), it is necessary to determine the VLM at each tide gauge to arrive at the climate change component of sea level changes by using independent geotechnical techniques (GPS, continuous GPS (CGPS), VLBI), absolute gravity, InSAR). Satellite altimetry providing absolute measurement of sea level variations is also used for estimates of VLM when combined with tide gauge records (Marc et al., 2004; Garcia et al., 2007).

6.2. Seasonal, interannual and interdecadal periodic variations in tide gauge’s sea level time series

The seasonal tide gauge data has been obtained from monthly sea level data of Antalya-I (1935-1977), Antalya-II (1985-2005), Bodrum-II (1985-2005), Menteş (1984-2005) tide gauges operated by General Command of Mapping, Geodesy Department, 06100 Dikimevi, Ankara/TURKEY. Has an YILDIZ, and Ali KILIÇOĞLU.

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