STERIC FLUCTUATIONS IN THE MEDITERRANEAN AS REFLECTED ON TIDAL GAUGE AND ALTIMETRY RECORDS

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ABSTRACT - Six years of T/P altimeter data and tidal gauge records from selected stations are used in order to assess the annual and interannual variability of sea level in the Mediterranean. Steric fluctuations induced by surface buoyancy fluxes account for about 50% of sea level variance. A predominant feature of the variability in the Aegean sea level is due to the excessive buoyancy loss and consequent dense water formation in early nineties.

1 – INTRODUCTION

The upper ocean steric height anomaly which is predominant at seasonal time scales arises mainly from near–surface changes in heat and freshwater content e.g. [Gill 73]. Satellite altimetry completes the available sea level dataset by providing open sea measurements. The length of the available altimetric measurements is hardly long enough even to provide stable estimates of the seasonal steric cycle. Nevertheless the comparison of the coastal tide-gauge data, with the altimetric measurements gives the opportunity to explore whether the coastal measurements are indeed representative of the basin variability at seasonal and interannual time scales.

2 – METHODS AND RESULTS

In this study the Mediterranean has been divided in the sub-regions of the Black Sea, Aegean, Levantine, Ionian, Adriatic, and West Mediterranean. Six years of T/P altimetry data (1992-1998) have been averaged for these regions and in addition representative PSMSL sea level records were analysed. The surface induced steric fluctuations were estimated by calculating the buoyancy flux which in turn was evaluated using the COADS, MODB and local meteorological datasets along with standard bulk formulae. Dardanelles outflow was parametrised as precipitation [Drak 98]. Although the thermosteric component is an order of magnitude stronger, in areas influenced by freshwater the salinity contraction term can be significant.

In Figs.1a,b,c, the sea level variability after inverse barometer correction is presented for three representative regions. The Aegean has the lowest normalised variance of the difference between the two datasets while Black Sea (not shown) has by far the highest (80%). This is attributed to the open sea location of the Aegean tidal gauge. If the seasonal cycle is removed by means of filtering there is better agreement in Adriatic and Western Mediterranean which reflects gauge records with better datum control.

Comparing the implied with the measured steric height, the agreement is not evident. Although the annual cycle is in phase, the steric fluctuation accounts for about 50% of T/P variance in most sub regions. Similar results were obtained in other studies [Larn 95]. The Adriatic due to its shallow nature has a stronger steric signal present. This figure for the Black Sea is only 10%, possibly due to hydraulic control in the strait of Bosphorus. In Fig 1d in solid the Aegean Sea filtered record is depicted; superimposed in dashes is the steric signal implied by the surface buoyancy flux. Clearly, some similarities are present in both time series. The dominant feature which is a continuous

lowering of sea level during 1991 - 1993 is present in both records. It reflects the formation of heavy (dense) waters in the area during that period of time.

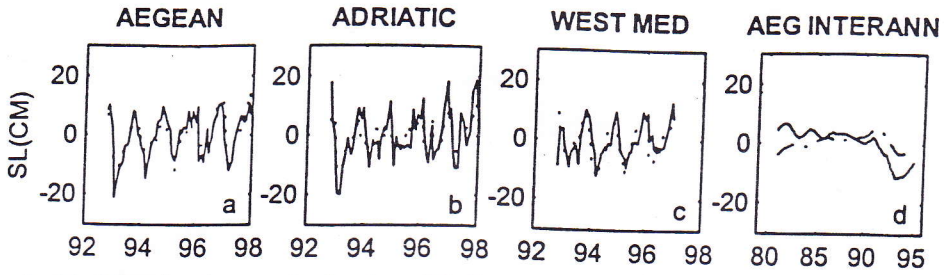

Fig. 1: (abc) Sea level anomaly for three Mediterranean regions. Tide gauges in solid, altimetry dotted. (d) Interannual steric fluctuation in the Aegean (Solid Tide gauge, dashed buoyancy implied)

Table 1: Sea level variances (cm^2) of the six studied regions according to tidal gauges, altimetry, implied from buoyancy fluxes, and difference of the last two.

	Black Sea	*Aegean*	*Levantine*	*Ionian*	*Adriatic*	*West Med*
Gauges	74	53	90	59	63	34
T/P	36	38	44	42	23	35
STERIC	7	22	27	20	14	17
T/P-STER	33	20	22	24	19	18

3 - CONCLUSIONS

For seasonal time scales, altimetry and tidal gauges have a better agreement away from closed seas whereas at interannual time scales the determinant factor seems to be the quality (datum control) of *in situ* measurements. Steric fluctuations induced by surface buoyancy fluxes account for about 50% of sea level variance. Unaccounted variance is expected to be due to bottom pressure but further investigation is needed [Pont 99]. The recent climatic changes in the Eastern Mediterranean are reflected on the sea level records as a drop in sea level, a result of excess buoyancy loss and consequent dense water formation in early nineties.

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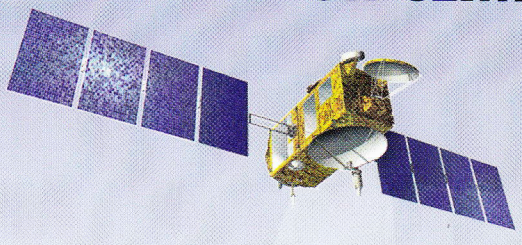

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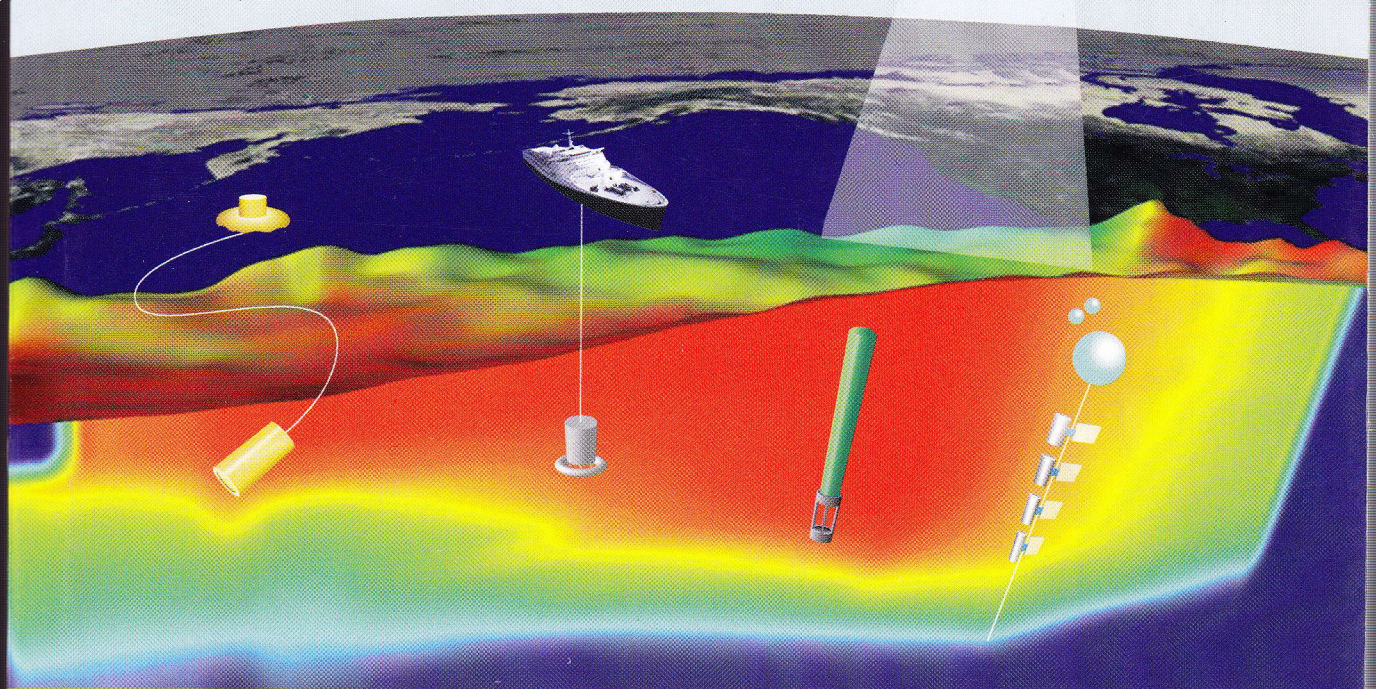

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