MEAN SEA LEVEL INVESTIGATION AT GLOBAL AND REGIONAL SCALES FROM TOPEX/POSEIDON

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We present updated results on the global mean sea level for 1993-mid 1997 based on reprocessed TOPEX/POSEIDON (T/P) altimetry data recently made available by the CNES AVISO project.

Global mean sea level

Figure 1 shows the mean sea level curve for that period, after removing the seasonal signal and 60-day smoothing. Since early 1993, the global mean sea level has been rising at a rate of 1.3 ± 0.15 mm/yr on the average. The result reported here disagrees with the series of recent sea level trend estimates published by Nerem and co-workers who find rates in the range of -0.2 mm/yr to +0.5 mm/yr, the most recent value based on the same time span as ours being -0.1 mm/yr [Nerem et al., 1997a, 1997b].

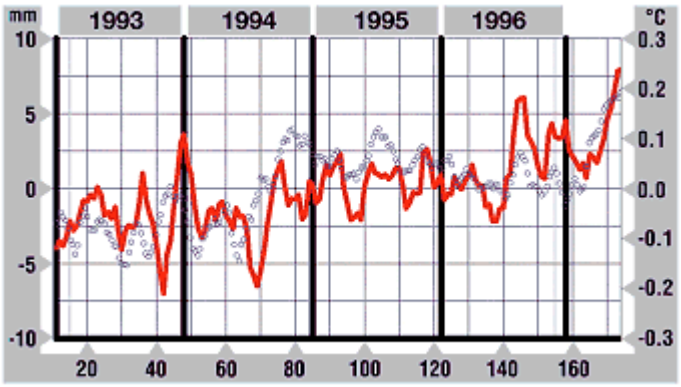

Figure 1
Global mean sea level curve (in mm) from T/P for 1993- mid 1997 (solid curve) and global mean sea surface temperature (dotted curve, in °C); seasonal components removed, 60-day smoothing, equi-area averaging between 60°N and 60°S.

The cause of this discrepancy is not yet understood. The mean sea level curve presented in Figure 1 shows step-like discontinuities in autumn 1994 and early spring 1997, also visible in the mean sea surface temperature (SST) curve. The observed steps in sea level are likely related to the 1994 and 1997 El Niños, and hence have a steric origin.

A map of the geographical pattern of the mean sea level slopes computed from T/P for four complete years (1993-1996) is presented in Figure 2.

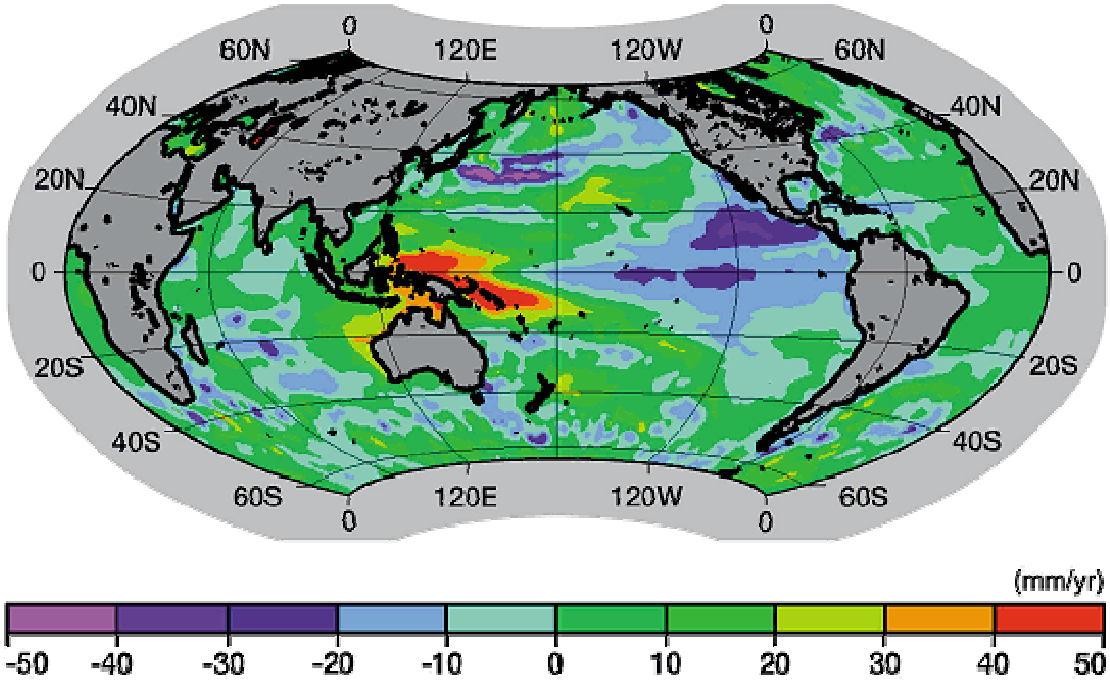

Figure 2

Geographical pattern of sea level slopes from T/P for 1993-1996 (in mm/yr).

The largest interannual signal originates in the tropical Pacific, a result consistent with the expectation that sea level slopes result from steric changes related to ENSO events [e.g., Chambers et al., 1997]. In particular, the large positive sea level slopes observed in the western equatorial Pacific result from year to year west-east swings in the positive sea surface height anomaly present along the equatorial Pacific in response to the series of recent El Niños. The basin scale-averaged sea level slopes are positive and on the order of 1 mm/yr.

Mediterranean Sea

Between January 1993 and December 1996, the Mediterranean mean sea level rose at an average rate of 13.2 ± 1.5 mm/yr. A steep rise occurred in Dec. 1995, possibly related to variations in the circulation in response to atmospheric forcing. Some correlation between SST and sea level is observed at intraseasonal but not at interannual time scales. The geographical distribution of sea level slopes computed for 1993-1996 shows a large positive signal in the eastern Mediterranean basin, in particular in the location of the Ierapetra Gyre, south-east of Crete. Almost all of the interrannual signal originates in the Levantine basin. Investigations are in progress to understand the origin of the observed interannual variations.

Caspian Sea

The Caspian sea exhibits large fluctuations in water level at decadal time scales, a result of regional climatic changes mostly affecting river runoff. Tide gauge records indicate that since 1978 the Caspian sea has been rising at a mean rate of +13 cm/yr. T/P data show that the Caspian sea level continued to rise at a rate of +19. ± 0.5 cm/yr until mid-1995 (Figure 3) and that the northwestern Caspian sea in the area of the Volga river delta was rising faster (by ~3 cm/yr) than the middle and south Caspian (Figure 4). However, during summer 1995, the Caspian sea level started to drop abruptly [Cazenave et al., 1997]. The Caspian sea level is

now falling at a huge rate of -25 ± 0.6 cm/yr. Although runoff from the Volga river has been decreasing during the last two years, the ultimate cause of this sudden and unexpected reversal is at present unknown. This new Caspian sea level trend could have dramatic economic consequences.

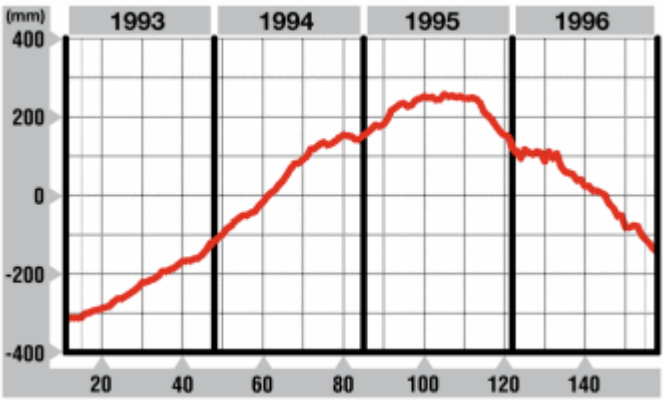

Figure 3
Interannual Caspian sea level fluctuations (in mm) from T/P between Jan. 1993 and Dec.1996.

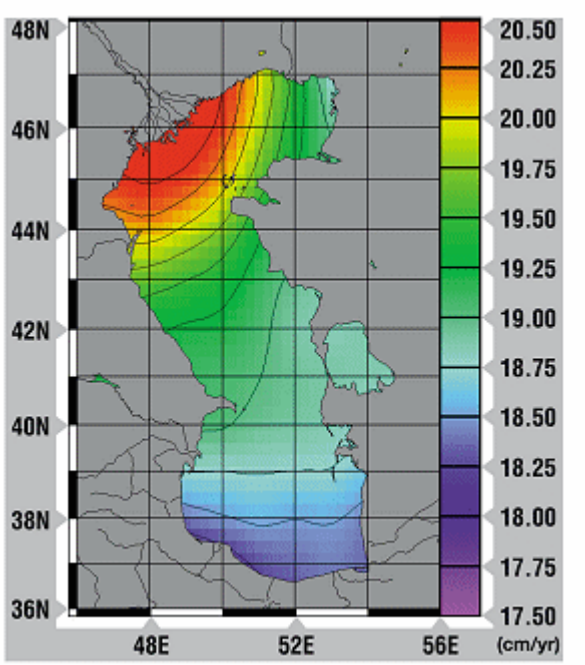

Figure 4
Geographical pattern of the Caspian sea level rise measured by T/P between January 1993 and July 1995 (in cm/yr).

References :

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