Sea level response to atmospheric oscillations on climatic and synoptic periods

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Sea level rise is one of the most disturbing possible consequences of global "greenhouse" warming. On climatic time scale global sea level rise about 10-20 cm/century (BARNETT, 1984) and according to W.R. Peltier (MEIER, 1990) during the past 50 years, sea level has been rising at an average of 2.4 ± 0.9 mm yr^{-1}. On the climate time scale the sea level rises due to CO_2-induced warming, low frequency fluctuations such as ice age e.t.c. This CO_2 increasing might lead to a rise of air temperature and so to a global sea level rise. On the other hand, at shorter time scale (about several days and weeks) sea level variability has been explained in terms of atmospheric pressure forcing which is impossible on climate time scale.

The purpose of this work is to find out:

- how variability in air pressure affects the sea level on climatic time scale and
- what happens with these processes on shorter time scale.

For these purposes yearly values of mean sea level and air pressure for the avaiable period (1890-1987 for Trieste and 1955-1987 for Split) were analysed. Relative values of mean sea level together with seven-year filtered values (PUGH, 1987) are plotted in Fig.1. Trend is evident for station Trieste. Fitted linear model leads to a slope of 0.1376 cm/year which is according to BARNETT value, of 13.66 cm/century (BARNETT, 1984).

In order to study the mean sea level response to the air pressure on climatic time scale, annual mean air pressure for station Trieste was analyzed for the same period as the sea level. Regression analysis between seven-year filtered values of sea level and air pressure data gives regression line with corresponding correlation coefficients (r=-0.28).

Relatively low correlation coefficient in Trieste data can be explained by existing mean sea level increase trend incomparable to far less pressure decrease trend. For station Trieste a linear trend in mean sea level and air pressure was obtained:

$PRE = 1015.55 - 5.435\ 10^{-4}\ t$
$MSL = 150.36 + 0.1376\ t.$

Detrended series gives a correlation coefficients of r=-0.727.

On the time scale of several days the sea level response to atmospheric pressure forcing was analyzed based of hourly data for station Split. After applying symmetrical 24M214 filter, smoothed curves are obtained (Fig.2.) containing signals of few-day period. Maximum correlation (r=-0.46) was found for lag of 43 hours which is in accordance with the synoptic scale.

In conclusion it may be pointed out that the sea-level changes on climatic time scale are not induced by the atmospheric pressure forcing because the air pressure negative trend contributions can be neglected. On the time scale of several days atmospheric pressure forcing is better pronounced.

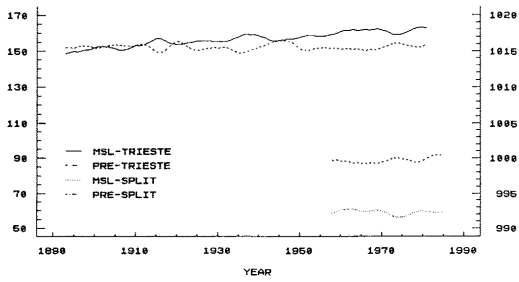

Figure 1. Filtered annual mean sea level and air pressure

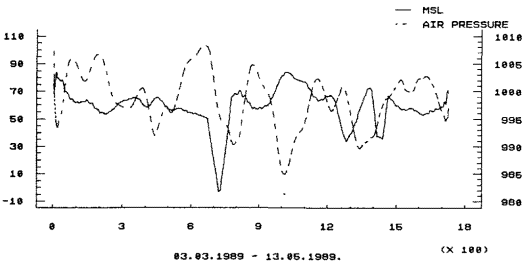

Figure 2. Filtered hourly values of mean sea level and air pressure for station Split

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