STATISTICAL ANALYSIS OF THE SEA LEVEL VARIABILITY IN THE SOUTHEASTERN SIDE OF THE CHANNEL (FRANCE)

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INTRODUCTION

The framework of this research is based on the SWOT project supported by CNES and NASA organizations.
We investigate the long term variability of the sea level in the southeastern side of the Channel using statistical methods in order to estimate the return values of sea level for recent changes in average and extreme conditions.

METHODOLOGY

The sea level at three stations (Dieppe, Havre and Cherbourg) was measured by tide gauge placed at the Dieppe, Havre and Cherbourg port, respectively (Figure 1). The data base was extracted from the REFMAR website provided by SHOM.

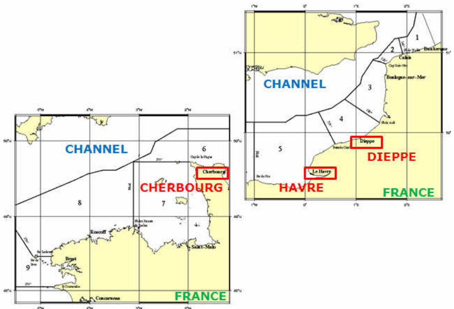

Figure 1. Dieppe, Havre and Cherbourg localisation, southeastern side of the Channel (France).

In this research, we have used a statistical method for gaps filling to generate a continuous data sets and estimate the sea level values. The ARMAX model structure is as given by:

$$y(t) = a_1.y(t-1) + ... + a_{n_a}.y(t-n_a)$$

$y(t)$: output at time t; na: number of poles;
$y(t-1)...y(t-na)$: Previous outputs on which the current output depends.

Then, the long term variability of the sea level was studied using : (1) the trend analysis of mean yearly sea level and (2) the continuous wavelets technique.

RESULTS

ARMAX PREDICTION FOR GAPS FULLING

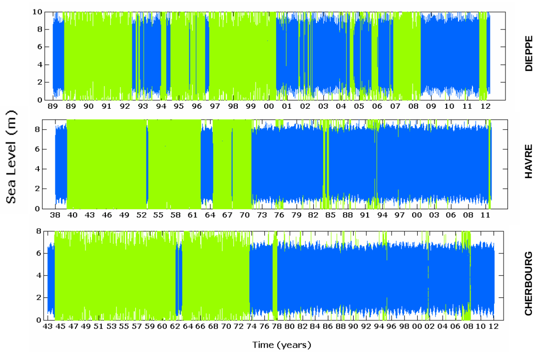

Figure 2. Timeseries of sea level. Original series (blue Color). Modeled values using ARMAX (green color)

CUMULATIVE DISTRIBUTION FUNCTION

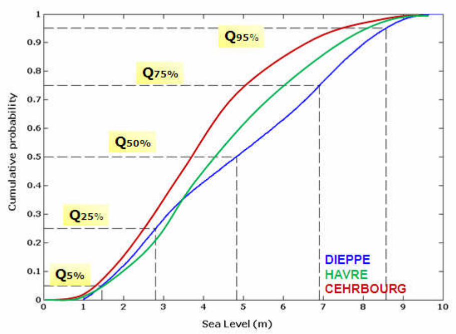

Figure 3. Cumulative Distribution Function of the sea level at Dieppe, Havre and Cherbourg. The quintiles more than 50% are higher at Cherbourg than those detected at Havre and Dieppe, respectively.

TREND ANALYSIS

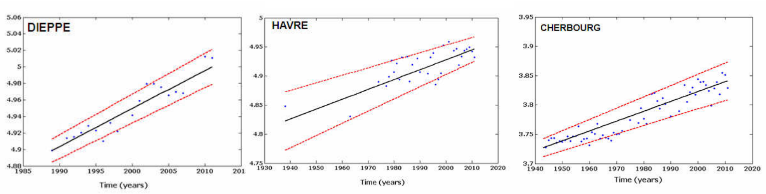

Figure 4. Trend Analysis of the yearly mean sea level. This trend was approximated to a linear form function of time using heteroscedastic method (mu representing the sea level and sigma is the variance of the distribution which is assumed Normal.
Linear equations: Dieppe mu=-4.2+0.046.t ; sigma=-0.61+0.18 E -04 .t
Havre mu=1.52+0.017.t ; sigma=0.82 E -04 -0.4 .t
Cherbourg mu=0.46+0.017.t ; sigma=-0.46+2.48 E -04 .t

CONTINUOUS WAVELETS ANALYSIS

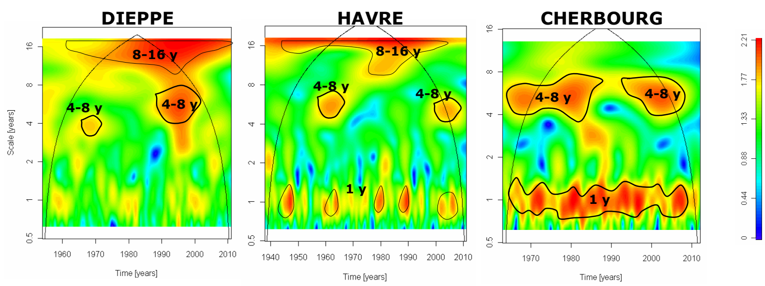

Figure 5. Continuous wavelets analysis of monthly sea level. The 1y and 4-8y are clearly observed at Cherbourg and less significant at Havre and then Dieppe. The low frequency of 8-16y are only manifested at Dieppe and Havre showing high energy.

CONCLUSION

The main finding of this research shows the following results:
1- The ARMAX model provides a good prediction of the sea level and can be used as a tool for filling gaps within timeseries in order to have a continuous data sets.
2- Extreme conditions of the sea level (quintiles more than 50%) in the southeastern side of the Channel show spatial variability explained by changes in energetic conditions along the same coastal zone. The evolution of these conditions in time shows also linear form with different velocities between stations.
3- Wavelet analysis displays a variability of high and low frequency which is differently manifested between stations.