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DECADAL AND INTERANNUAL SEA LEVEL CHANGE

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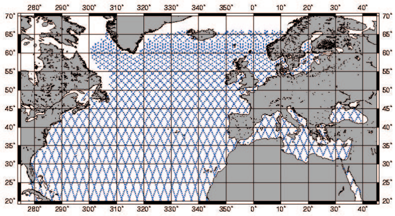
1. ABSTRACT



Interannual to decadal sea level variations are estimated from Topex altimetry and from tide gauge data over the interval 1992 - 2002 in the North Atlantic Ocean and in the semienclosed European Seas.

Figure 1: North Atlantic and adjacent european sea region with Topex/Poseidon tracks

2. METHOD OF ANALYSIS

Tide gauge monthly values of the PSMSL dataset and monthly averages computed from hourly data (SONEL, SIMN datasets) are used. Altimeter time series are constructed by averaging the Topex altimeter data temporally in monthly means and spatially in grids with meshes of 1x1 degrees. Ocean tide, load tide, earth tide and polar tide corrections have been applied to the altimeter data, as they average out in the tide gauge monthly means. The inverse barometer effect is not applied to the altimeter data, as it does not average out in evaluating the mean of the tide gauge data over a month.

For each time series both the linear term (decadal variability) and the average variability over each month (annual variability) are estimated. The power spectrum of the residuals gives the interannual components of the variability.

3. DECADAL VARIABILITY

The decadal sea level change is mostly positive and lower than 6 mm/yr with exception of the Ionian Sea (up to 10 mm/yr) in the Mediterranean Sea and of the Gulf Current in the eastern Atlantic Ocean. Higher values are observed in the eastern Mediterranean Sea (up to 10 mm/yr) and in the Black Sea (up to 14 mm/yr).

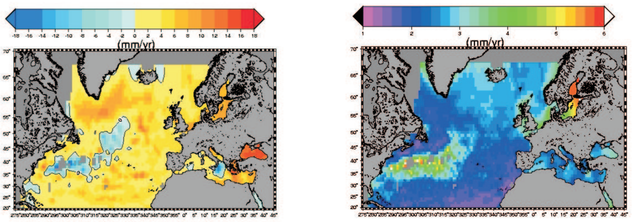


Figure 2: Decadal sea level change and ist standard errror

4. INTERANNUAL VARIABILITY

The decadal variability as well as the seasonal variability are removed from the time series. The spectrum of the interannual variability is evaluated in each grid point. Maps of the first four dominant components of the spectrum of the residuals are build (Figure 4). The first component of the spectrum has a confidence level higher than 90% in the Tropic Atlantic Ocean, in the eastern Mediterranean and in the Baltic Sea and corresponds to frequencies lower than 0.8 Cyc/yr.

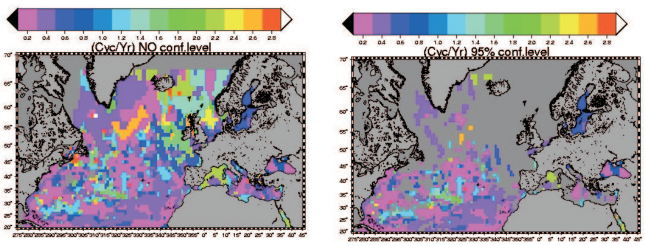


Figure 3: First spectral components of the interannual variability field without check for the 90% confidence level (left) and with check (right).

The maps of interannual variability identify regions with similar long term variability. The following regions are identified:

A) Mediterranean Sea
B) Baltic Sea
C) North Sea
D) Black Sea
E) North Atlantic Ocean > 45 degrees
F) North Atlantic Ocean < 45 degrees

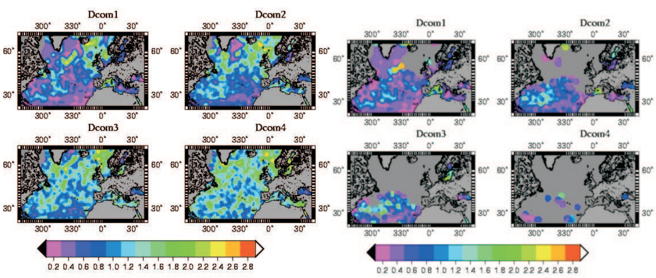
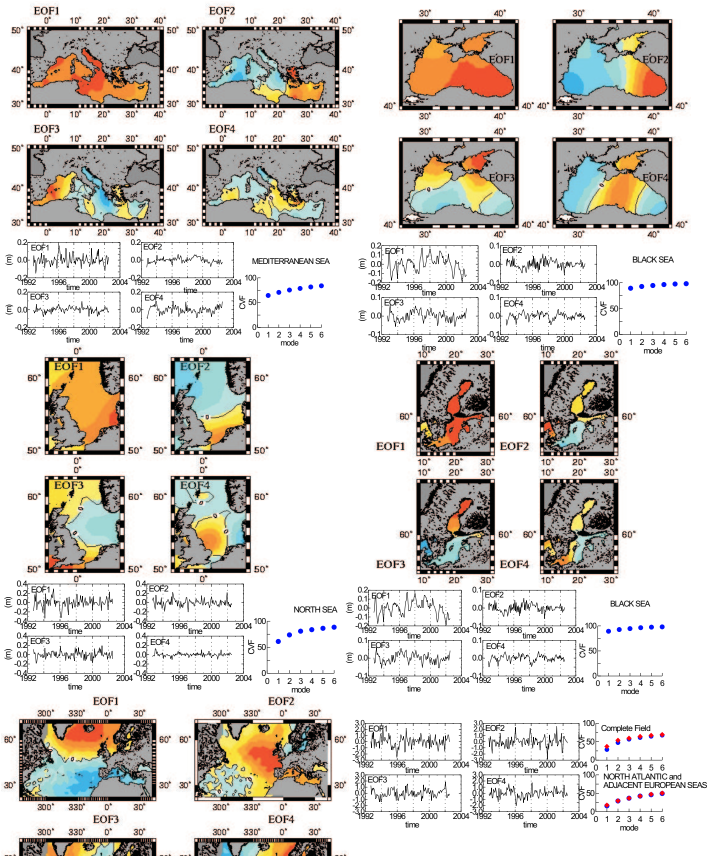


Figure 4: Four dominant frequency of the spectrum of interannual variability (left) and with 90% confidence level (right)

4.1 Regional characteristics

The main components of the variability are represented using an EOF analysis.



EOF	Med. Sea	Black Sea	North Sea	Baltic Sea	North Atlantic & adj. europ. seas
1	64.6	89.2	61.1	90.6	15.9
2	6.4	3.4	12.6	3.5	13.3
3	4.8	1.9	7.0	2.6	7.5
4	3.1	1.8	2.9	0.7	5.7

Table 1: Variance Fraction of the first EOF modes

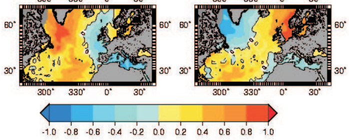


Figure 5: Spatial and temporal patterns of the EOF modes of the interannual variability. Non-standardised anomalies are used in the regional maps. Standardized anomalies are used in the North Atlantic and adjacent european seas maps.

5. Altimetry and tide gauge comparison

The same method of analysis is used to process the monthly tide gauge time series. The results are compared over the last decade. A good agreement exists in general between the decadal, seasonal and interannual components of the altimetry and tide gauge time series (Fenoglio-Marc 2002, FEnoglio-Marc 2003, Fenoglio-Marc and Groten 2003). Comparison of the spectra at a few locations (Figure 7) shows differences in the low spectral frequencies (0.2 Cyc/yr) in the Mediterranean Sea.

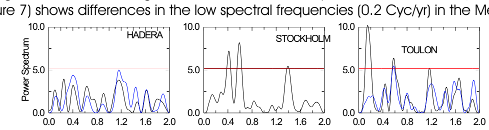


Figure 6: Power spectra of interannual variability at the tide gauge station (black) and at the nearest grid point (blue).

6. CONCLUSIONS

Decadal and interannual sea level variability have been analysed over one decade from Topex altimeter data of the Pathfinder database.

Once the decadal linear trend and the seasonal part have been removed, the dominant modes of the interannual variability have been identified. Very few modes are necessary to describe the interannual variability in the closest basins, the Baltic Sea and the Black Sea, as the first mode account for most of the interannual variability (about 90%).

First analysis with monthly tide gauge data over the same decade show a good agreement. Departures between the spectra of monthly values at the tide gauge and of monthly averaged in space grid values can

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