

Introduction and Objective

The impact of climate change on sea level has received a great deal of attention by scientists worldwide. In this context, the problem of sea levels on global and regional scales have been analyzed in a number of studies based on tide gauges observations and satellite altimetry measurements. estimates

This study focuses on local sea level trend estimation from three (03) high quality tide gauge stations along the West African coast : Senegal, Mauritania and Cape Verde.

Info... *Trend : a smooth component containing information about time series global change that shows, on one hand, the slow rise in the sea level under the combined effect of thermal expansion due to the steric effect, precipitation, etc. and on the other hand, the effect of extreme weather events.*

Tide gauge data

The study of the trend of sea level variability does not necessarily require direct manipulation of hourly tide gauge data. Indeed, the mechanism for calculating of average hourly data for one month or one year filters the fluctuations of short period observed in tide gauge records, that they are of irregular nature (waves of storm, tidal wave...) or periodical (diurnal, tidal waves, tides...).

The time series of monthly or annual averages are consequently suitable under investigation of the sea level variability.



We analyzed the available monthly averaged sea level series from the Permanent Service of Mean Sea Level (PSMSL), i.e., those checked in terms of quality, continuity and local stability of the tide gauge reference.

Methods

Trend test : The Mann-Kendall test is a nonparametric test that is commonly used to detect the presence or not of significant trends in environmental, climate or hydrological time series. The null hypothesis, H_0 is that the data come from a population with independent realizations that does not follow any trend. The alternative hypothesis, H_1 , is that the data follow a clear monotonic trend.

Time series decomposition : The result of this processing is a decomposition of the three time series into several components, which can be identified as a non linear trend, seasonalities and noise components.

- STL : Seasonal and Trend decomposition using Loess
- ARIMA : AutoRegressive Integrated Moving Average
- SSA : Singular Spectrum Analysis

Experimental Results

Descriptive statistics of the used data

PSMSL Station ID	Station	Latitude (°)	Longitude (°)	Data range	Completeness	Slope (mm/year)
1816	Dakar 2	14.683333 N	17.416667 W	1993-2018	78.53 %	1.52 ± 0.61
1914	Palmeira	16.750000 N	22.983333 W	2001-2018	93.06 %	4.22 ± 0.51
2036	Nouakchott	17.989556 N	16.036958 W	2008-2014	90.48 %	24.94 ± 5.64

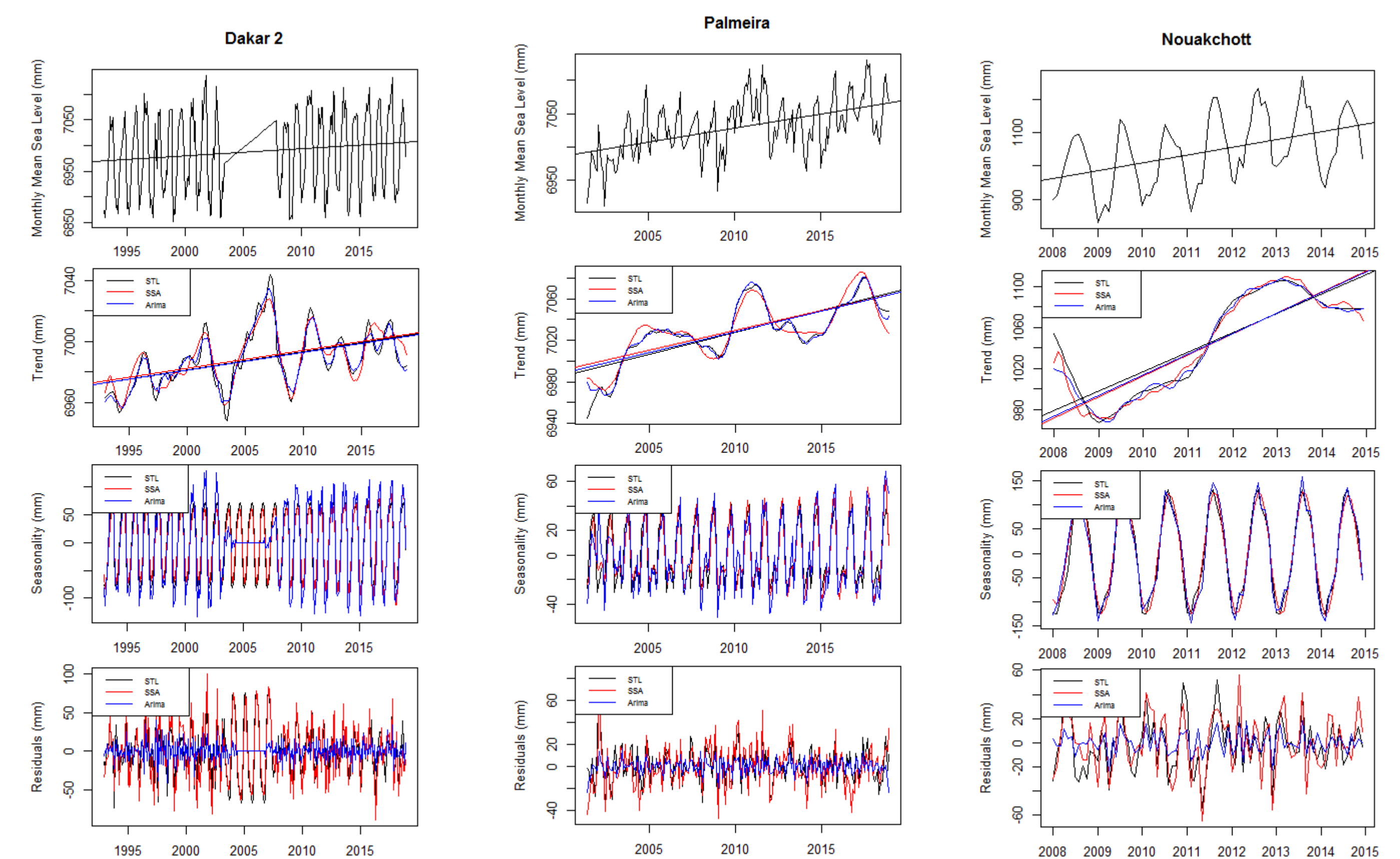
Mann-Kendall test, $\alpha=0.05$

H_0 : There is no trend in the series, H_1 : There is a trend in the series

PSMSL Station ID	Station	Data range	Seasonal Mann-Kendall statistic S	Var S	P - Value	Risk to reject the null hypothesis while it is true (%)
1816	Dakar 2	1993-2018	6335	3390581	<0.001	0.06
1914	Palmeira	2001-2018	8042	1050963	<0.0001	0.00
2036	Nouakchott	2008-2014	1037	66999.66	<0.0001	0.01

The obtained p values are lower than the fixed significance level ($\alpha=0.05$). One should reject the null hypothesis H_0 , and accept the alternative hypothesis H_1 . Positive trends in our sea level series ($S>0$)

Time series decomposition



VLM (Vertical Land Motion): ICE-6G Model of Peltier, 2015

PSMSL Station ID	Station	Data range	Trend in original series	STL Slope (mm/year)	SSA Slope (mm/year)	ARIMA Slope (mm/year)	VLM (mm/year)	Arima Slope VLM corrected (mm/year)
1816	Dakar 2	1993-2018	99.99 %	1.18 ± 0.12	1.19 ± 0.11	1.18 ± 0.11	-0.34	1.52
1914	Palmeira	2001-2018	99.99 %	4.24 ± 0.26	3.81 ± 0.25	4.01 ± 0.26	-0.50	4.51
2036	Nouakchott	2008-2014	99.21 %	18.87 ± 1.44	20.46 ± 1.35	19.83 ± 1.43	-0.25	20.08

The highest trend estimated at Nouakchott Station of 20.08 mm/year may be due to a high subsidence rate.

Conclusions

The seasonal Mann-Kendall test is performed to identify statistically the presence or not of significant trends in the tidal height series: Senegal, Mauritania and Cape Verde. **All tide gauge stations exhibit a significant positive trend.**

A second analysis was carried out in order to decompose these three series into several components, which can be identified as a non linear trend, seasonalities and noise components. **The findings by using the three techniques STL, SSA and Arima are very similar.**

After correction for vertical land motions (VLM) due to postglacial rebound, the magnitudes of sea level changes are: **Dakar 2 : +1.52 mm/year (1993-2018), Palmeira : +4.51 mm/year (2001-2018) and Nouakchott : 20.08 mm/year (2008-2014).**