Method for filling the gaps in long time series.

As explained in the main text, those time series beginning in 1990 or earlier were selected for their analysis. These long time series present some gaps. Those gaps shorter than three months were filled by interpolation by means of natural cubic splines. For the longer gaps we selected those sea level series from nearby tide gauges. Figure S1 exemplifies the followed procedure. Black line in Figure S1 shows the time series of sea level anomalies (sea level minus the average seasonal cycle) at Algeciras. This is the series that we want to complete in this example.
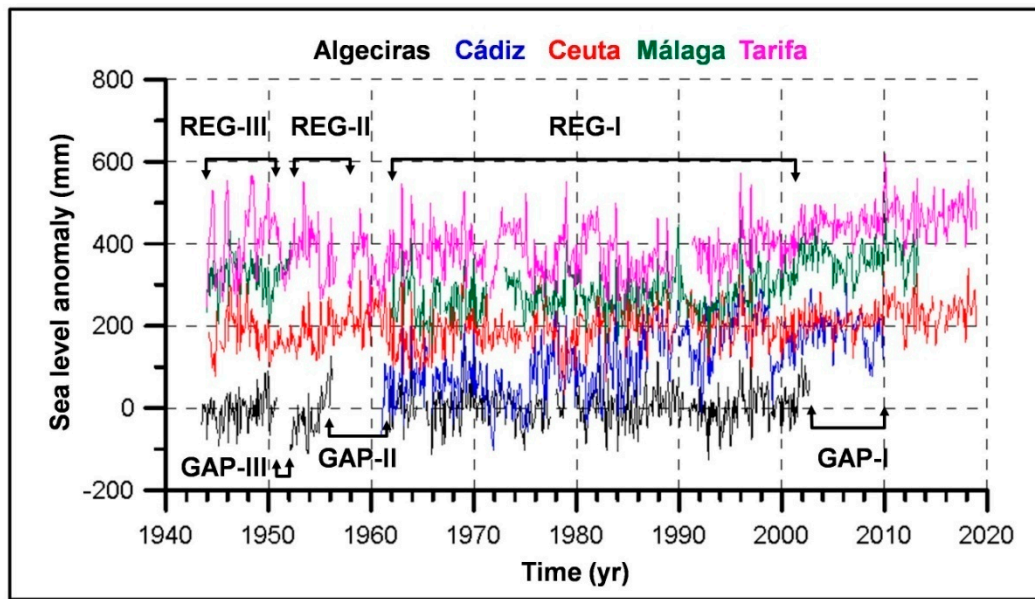
GAP-I shows a period of time, from 2002 to 2010 when there are no data at Algeciras. During this period, sea level data are available for the nearby tide gauges in Cádiz (blue line), Ceuta (red line), Málaga (green line) and Tarifa (magenta line). Therefore, we could reconstruct the Algeciras time series for this period if we knew a linear relation between the Algeciras data (dependent variable) and the predictors (Cádiz, Ceuta, Málaga and Tarifa). This relation can be obtained by means of multiple linear regression. To perform this regression we need a period of time when both the dependent variable and the predictors are available. In this case this period is REG-I. Once the coefficients have been estimated, the period GAP-I is reconstructed.

Other gaps are marked in Figure S1 as GAP-II and GAP-III. During these periods, only Ceuta (red) and tarifa (magenta) data are available. Hence we could reconstruct Algeciras time series for GAP II and GAP III if we knew a linear relationship between Algeciras sea level and Ceuta and Tarifa time series. Notice that we cannot use the same coefficients from the previous regression. The coefficients that relate Algeciras to Ceuta and tarifa are not the same than those coefficients relating Algeciras with Cádiz, Ceuta, Málaga and Tarifa, as the inclusion of new predictors changes the result of the regression. Therefore we regress Algeciras sea level on Ceuta and Tarifa using all the periods when data from these three locations are available. These periods are REG I + REG-II + REG-III. Once the coefficients have been estimated, the time series of sea level at Algeciras can be reconstructed for the periods GAP-II and GAP-III.

We can fill all the gaps as long as we have data from nearby tide gauges corresponding to such gaps and there is a common period when the dependent variable (the one to be reconstructed) and the predictors are available. In some cases the reconstruction is carried out using one single predictor, in other cases several predictors are available.

Table S1 shows the time series reconstructed (column 1), and those used as predictors for different gaps (column 2). Column 3 shows the multiple correlation coefficients (Draper, 1981) which is the square root of the variance explained by the multiple linear regression. Notice that in some locations there are several tide gauges operated by different institutions. In these cases the longest time series has been used for its analysis and the data from the other tide gauges have been used for filling the gaps in the long time series.

Notice the high correlation coefficient which indicates that the regression is able to explain a large fraction of the variance of the original time series. The quality of the reconstruction relies on this high correlation.

In some tide-gauges some errors were detected. Such errors were corrected using a similar method. In the case of Vigo tide-gauge, sea level decreased after 1998 (see red line in Figure S2A). This behavior was not observed in the altimetry data, nor in the Vigo2 tide-gauge, which is at the same location. For this reason data at Vigo after 1998 were discarded. The period 1998-2019 is considered as GAP-I in figure S2B. The tide-gauge Vigo2 started to operate in 1993, therefore there is common period for Vigo and Vigo2, which is named as REG-I. The regression of Vigo on Vigo2 for this common period allowed us to extend Vigo data without the use of the suspicious ones (Figure S2C).
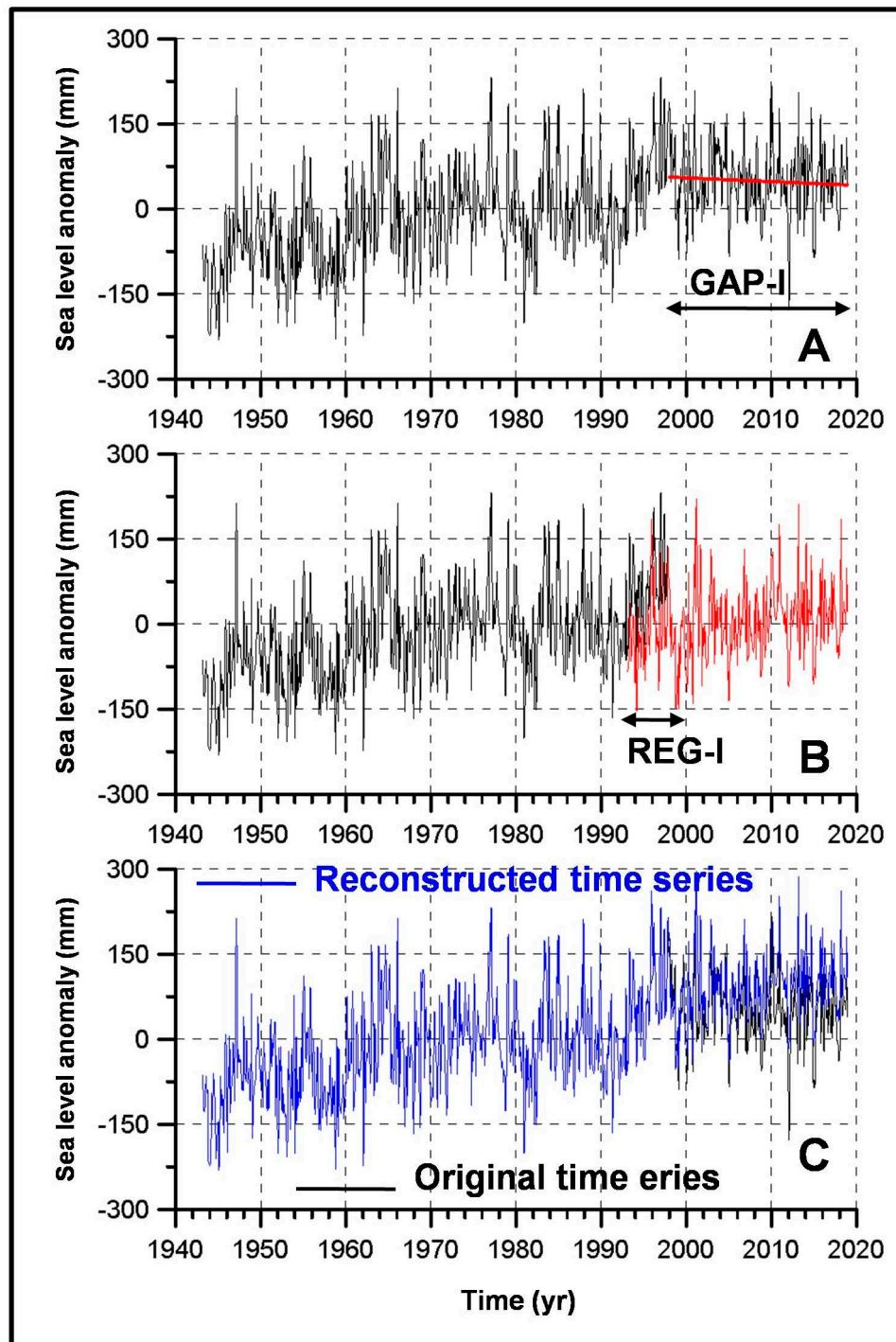
Table S1. Column #1 shows the long time series that are analyzed in this work. Column #2 shows the predictors or time series that are used to fill the gaps in the long time series. In some cases there are two different lines. This means that different predictors have been used for different gaps. For instance, one gap in Santander time series was filled with data from Bilbao, and another gap was filled with data from Pasaia. The third column shows the multiple correlation coefficient for the regression of the dependent variable on the predictors.

Independent variable	Predictors	Correlation coefficient (R)
Santander	Bilbao	0.96
	Pasaia	0.87
A Coruña	Vigo	0.78
	Leixoes	0.69
Vigo	Vigo2	0.79
	Leixoes	0.71
Leixoes	Vigo + A coruña	0.76
Cascais	Setroia	0.84
	Sines	0.83
Cádiz	Ceuta + Málaga	0.58
	Málaga	0.53
	Ceuta	0.53
	Cádiz2	0.99
Tarifa	Tarifa2	0.92
	Málaga	0.65
Algeciras	Cádiz + Ceuta + Málaga +Tarifa	0.79
	Ceuta + Málaga + Tarifa	0.74
	Ceuta + Tarifa	0.65
Ceuta	Cádiz + Gibraltar + Málaga + Málaga2 + Tarifa	0.88
Gibraltar	Ceuta + Málaga + Málaga2 + Tarifa	0.85
	Algeciras + Ceuta + Málaga + Tarifa	0.68
	Algeciras + Ceuta + Tarifa	0.64

Málaga	Cádiz + Ceuta + Gibraltar + Málaga2 + Tarifa	0.94
	Ceuta + Tarifa	0.69
	Málaga2	0.91
Alicante out	Alicante in	0.84
L'Estartit	Barcelona	0.91
Palma	Palma2	0.82
Arrecife	Arrecife2	0.89
	Arrecife3	0.81
Las Palmas	Las Palmas2	0.93

Table S2. Linear trends for the steric sea-level change.

Linear trends for the steric sea-level change		
Location	Period	Steric SLC (mm/yr)
Santander	1948-2019	0.99 ± 0.13
	1993-2019	1.95 ± 0.52
Vigo	1948-2019	0.30 ± 0.14
	1993-2019	1.5 ± 0.4
A Coruña	1948-2019	0.40 ± 0.24
	1993-2019	1.9 ± 0.4
Leixoes	1948-2019	0.35 ± 0.15
	1993-2019	1.7 ± 0.5
Cascais	1948-2019	0.70 ± 0.21
	1993-2019	1.4 ± 0.5
Arrecife	1948-2019	0.86 ± 0.11
	1993-2019	0.5 ± 0.4
Las Palmas		
	1993-2019	1.4 ± 0.4
Tenerife	1948-2019	0.87 ± 0.12
	1993-2019	1.9 ± 0.5
Cádiz	1948-2019	0.26 ± 0.20
	1993-2019	3.5 ± 0.9
Tarifa	1948-2019	0.27 ± 0.21
	1993-2019	4 ± 1
Algeciras	1948-2019	0.27 ± 0.21
	1993-2019	4 ± 1

Gibraltar	1948-2019	0.27 ± 0.21
	1993-2019	4 ± 1
Ceuta	1948-2019	0.27 ± 0.21
	1993-2019	4 ± 1
Málaga		
	1993-2019	2.7 ± 0.9
Alicante	1948-2019	-0.50 ± 0.15
	1993-2019	-1.3 ± 0.7
L'Estartit		
	1993-2019	-3.4 ± 0.4
Palma		
	1993-2019	-2.7 ± 0.5

Table S3. Coefficients and multiple regression coefficient for the forward stepwise regression of sea level on time, P, U, V, and the steric sea-level change (without decomposing it into its thermosteric and halosteric components).

1948-2019 Location	Time mm/yr	Pressure mm/mbar	U-wind mm/ms^{-1}	V-wind mm/ms^{-1}	Steric	R
Santander	2.08 ± 0.21	-9.4 ± 0.9	8.2 ± 2.1	14.9 ± 2.3		0.85
Vigo	2.66 ± 0.24	-11.6 ± 1.1	-11.31 ± 2.3	20.2 ± 2.4		0.85
A Coruña	2.29 ± 0.22	-9.9 ± 1.0	-5.4 ± 2.2	18.1 ± 2.3		0.84
Leixoes	1.61 ± 0.20	-8.4 ± 1.0		21.0 ± 2.1		0.81
Cascais	1.62 ± 0.19	-11.3 ± 1.0	-5.1 ± 1.4	4.0 ± 1.2	0.07 ± 0.04	0.84
Arrecife	0.59 ± 0.16	-9.3 ± 1.8			0.11 ± 0.09	0.46
Las Palmas						
Tenerife	1.59 ± 0.12	-12.3 ± 1.3			0.10 ± 0.06	0.83
Cádiz	2.62 ± 0.21	-12.1 ± 1.8	-10.0 ± 2.5	6 ± 3		0.75
Tarifa	1.38 ± 0.21	-12.7 ± 2.0	-7.9 ± 2.1	15 ± 7	0.22 ± 0.05	0.64
Algeciras	1.00 ± 0.14	-11.8 ± 1.2	-6.8 ± 1.3	13 ± 4	0.10 ± 0.03	0.72
Gibraltar	-0.18 ± 0.16	-10.6 ± 1.5	-6.3 ± 1.7	18 ± 5	0.17 ± 0.04	0.62
Ceuta	0.89 ± 0.15	-12.6 ± 1.3		12 ± 5		0.69
Málaga	1.40 ± 0.19	-14.1 ± 1.3	-11.6 ± 1.8		0.17 ± 0.05	0.71
Alicante	0.82 ± 0.17	-13.6 ± 1.0	-6.2 ± 1.8	7 ± 3		0.76

L'Estartit						
Palma						

References.

Draper, N.R. & H. Smith, 1981. Applied regression analysis. (2nd Ed.) New York: Wiley.