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SHORT COMMUNICATION

Short-Term Tide Gauge Records from One Location are Inadequate to Infer Global Sea-Level Acceleration

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Abstract

Background Long records of sea level show decadal and multi-decadal oscillations of synchronous and asynchronous phases, which cannot be detected in short-term records. Without incorporating these oscillations, it is impossible to make useful assessments of present global accelerations and reliable predictions of future changes of sea level. Furthermore, it is well known that local sea-level changes occur also because of local factors such as subsidence due to groundwater or oil extraction, or tectonic movements that may be either up or down.

Purpose Limited data from limited areas of study are, therefore, unsuitable for making predictions about the whole world sea level. Yet, people continue to make such predictions, often on an alarming scale. Here, we use one example to illustrate the problems associated with trying to make sea-level predictions based on a short record (25 years) in a limited region.

Methods Linear and parabolic fittings of monthly average mean sea levels (MSL) of global as well as different local (United States Atlantic Coast, United States Pacific Coast) data sets of long tide gauge records.

Results It is clear from the analyses of the tide gauges of the "NOAA-120", "US 39", "PSMSL-162", "Mitrovica-23", "Holgate-9", and "California-8" data sets and the United States Pacific and Atlantic coasts that the sea level has been oscillating about the same almost perfectly linear trend line all over the 20th century and the first 17 years of this century.

Conclusion It is of paramount importance to discuss the proper way to assess the present acceleration of sea levels. This can not be done by focusing on the short-term upward oscillations in selected locations. The information from the tide gauges of the United States does not support any claim of rapidly changing ice mass in Greenland and Antarctica. The data only suggest the sea levels have been oscillating about the same trend line during the last century and this century.

Keywords Sea-level rise · Sea-level acceleration · Short records · Phases of the oscillations

1 Introduction

Sea levels are oscillating, with well-known inter-annual, decadal and multi-decadal oscillations well evidenced in the measurements collected by tidal gauges. There are oscillations of synchronous and non-synchronous phases moving from one location to another. Furthermore, it is well known that local sea-level changes occur also because of local factors such as subsidence due to groundwater or oil extraction, or tectonic movements that may be either up or down. Relative sea-level changes due to subsidence or uplift are sometimes far larger than the global average sea-level changes. Conclusions regarding the acceleration of global sea-level rise require the analysis of time series from different locations over time windows long enough to clear any long-term departure from a linear trend of the shorter-term oscillations. Any subsidence or uplift of the tide gauge should also be considered for a proper estimation.

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Short sea-level records may provide unrealistic estimations of the rates of rise of sea levels by linear fitting because of the decadal and multi-decadal oscillations (Douglas 1992). Douglas examined the long tide gauge records (75 years minimum) for deviation from a purely linear rise, the apparent sea-level acceleration. Over the period 1905–1985, 23 essentially complete tide gauge records 80 years long in 10 geographic groups produced an apparent global acceleration of -0.011 ± 0.012 mm/year^2. A larger, less uniform set of 37 records in the same 10 geographic groups of average length 92 years provided an apparent acceleration of $+0.001 \pm 0.008$ mm/year^2. Douglas concluded that there was no evidence for a significant apparent acceleration in the past 100 + years. Douglas also showed by dividing the 1905–1985 data set into four equal time spans of 20 years that the short time windows would have been particularly misleading due to the large interdecadal and longer oscillations of sea level.

Temperature records also show oscillations. Oscillations of up to quasi-60 years have been observed in the global climate system by Schlesinger and Ramankutty (1994) who show that global-mean surface temperature records display substantial variability on timescales of a century or less. They identify a temperature oscillation with a period of 65–70 years. Singular spectrum analysis of the surface temperature records for 11 geographical regions shows that the 65- to 70-year oscillation is the statistical result of 50- to 88-year oscillations for the North Atlantic Ocean and its bounding Northern Hemisphere continents. The sea levels oscillate following these global temperature oscillations (as well as other periodicities).

The world tide gauges have different inter-annual and multi-decadal periodicities of up to quasi-60 years (Chambers et al. 2012; Parker et al. 2013; Parker 2013a, b, 2014). Chambers et al. (2012) examined the long tide gauge records in every ocean basin to find that there is a significant oscillation with a period around 60-years in most the tide gauges examined and that it appears in every ocean basin. Averaging of tide gauges over regions shows that the phase and amplitude of the fluctuations are similar in the North Atlantic, western North Pacific and Indian Oceans, while the signal is shifted by 10 years in the western South Pacific. The only sampled region with no apparent quasi-60-year fluctuation in the analysis by Chambers et al. (2012) was the Central/Eastern North Pacific.

Parker et al. (2013) indicated the need to use at least 60 years of data to infer reasonable trends of sea-level rise by using global and Australian data. Parker (2013a) analysed the sea-level trends at those locations in the USA with more than 100 years of recording to conclude that the sea levels have been only oscillating since the start of the twentieth century, with significant multi-decadal periodicities on both the Pacific and Atlantic Coasts. Parker (2013b) demonstrated that the oscillations of sea-level rise along the Atlantic Coast of North America north of Cape Hatteras that occurred in recent times were also experienced 60 years before, while Parker (2014) demonstrated as the apparent "hot spots of acceleration" along the Atlantic Coasts of the USA were coupled to apparent "cold spots of acceleration" (i.e. deceleration) along the Pacific Coast of the USA and the Hawaii Islands. In brief, the East and West Coasts of the USA are subjected to different phases of the decadal and multi-decadal oscillations.

Parker and Ollier (2016) maintained that local sea-level forecasts should be based on proven local sea-level data. Their naïve averaging of all the tide gauges included in the PSMSL surveys showed "relative" trends of about + 1.04 mm/year (570 tide gauges of any length). By only considering the 100 tide gauges with more than 80 years of recording, the average trend was only + 0.25 mm/year. This naïve averaging has been stable in recent decades, and it shows that the sea levels are slowly rising but not significantly accelerating. They conclude that if the sea levels are only oscillating about constant trends everywhere, then the local patterns may be used for local coastal planning without any need to use purely speculative global trends based on emission scenarios.

The loud divergence between sea-level reality and climate change theory—the climate models predict an accelerated sea-level rise driven by the anthropogenic CO_2 emission—has been also evidenced in other works such as Boretti (2012a, b), Boretti and Watson (2012), Douglas (1992), Douglas and Peltier (2002), Fasullo et al. (2016), Jevrejeva et al. (2006), Holgate (2007), Houston and Dean (2011), Mörner 2010a, b, 2016), Mörner and Parker (2013), Scafetta (2014), Wenzel and Schröter (2010) and Wunsch et al. (2007) reporting on the recent lack of any detectable acceleration in the rate of sea-level rise. The minimum length requirement of 50–60 years to produce a realistic sea-level rate of rise is also discussed in other works such as Baart et al. (2012), Douglas (1995, 1997), Gervais (2016), Jevrejeva et al. (2008), Knudsen et al. (2011), Scafetta (2013a, b), Wenzel and Schröter (2014) and Woodworth (2011).

As an example of short-term measurement in a limited area, we consider the results of Davis and Vinogradova (2017). They consider time windows of only 25 years and only selected locations along the East Coast of North America. They neglect all other information in their selected locations and ignore results from other locations such as the West Coast of North America. Nevertheless, they draw global conclusions about sea level and the mass change in the ice of Greenland and Antarctica that per them has occurred since 1990.

Aim of this paper is to show that the information from the tide gauges of the USA and the rest of the world when considered globally and over time windows of not less than 80 years (but 120 years, or twice the quasi-60 years' periodicity, work even better) does not support the notion of rapidly changing mass of ice in Greenland and Antarctica as claimed by Davis and Vinogradova (2017). The sea levels have been oscillating about a nearly perfectly linear trend since the start of the twentieth century with no sign of acceleration. There are only different phases of some oscillations moving from one location to another that do not represent any global acceleration.

2 Sea-Level Trend and Acceleration

Sea-level trends are typically computed by linear fitting of the measured monthly average mean sea levels (MSL) for tide gauge locations. Sea-level accelerations are usually computed by the parabolic fitting of the MSL. If x is the time and y the monthly average mean sea level (MSL), by using a linear regression:

$$y = A + Bx, \tag{1}$$

and a quadratic regression:

$$y = C + Dx + Ex^2, \tag{2}$$

B is then the trend (slope) $\mathrm{d}y/\mathrm{d}x$ while $2{\cdot}E$ is the acceleration $\mathrm{d}^2y/\mathrm{d}x^2$. These values are obviously values averaged over the time window of the analysis.

It is intuitive that the sea-level accelerations computed by parabolic fitting (2) are even more sensitive to the short time windows than the sea-level trends computed by linear fitting (1). Because of the decadal and multi-decadal oscillations, if not in the case of extremely short records, a positive sea-level trend may only oscillate about slightly larger or slightly smaller values. Conversely, a practically zero sea-level acceleration may change towards drastically different, large positive or negative, values because of the decadal and multi-decadal oscillations.

Other approaches have been proposed to compute the sea-level acceleration (see, e.g. Parker et al. 2013 or http://tidesandcurrents.noaa.gov/sltrends).

Alternative "acceleration" parameters are, for example, the time rate of change of the trend $\mathrm{d}B/\mathrm{d}x$, with B computed at different times by either using all the data available at the given times or a fixed length time window.

Parker et al. (2013) also propose to use the parabolic fitting (2) not of the MSL, but of the departures of the MSL from a linear and multiple sinusoidal oscillations:

$$\begin{aligned}\delta y &= y - A - Bx - \sum_{i=1}^{n} F_i \sin\left[\frac{\pi(x - x_{c,i})}{w_i}\right] \\ &= C + Dx + Ex^2,\end{aligned} \tag{3}$$

where n is the number of sinusoidal functions representing the inter-annual, decadal and multi-decadal oscillations and A, B, F_i, $x_{c,i}$, w_i is the fitting coefficients. While the use of (3) rather than (2) may reduce the sensitivity to the record length, all these different approaches bring to the same conclusion that the sea levels have been not accelerated since the start of the twentieth century.

Davis and Vinogradova (2017) use a 25 years' short-term logic for the tide gauges of the East Coast of the USA while neglecting all the other tide gauges of the USA to come to a global conclusion for the loss of ice on land in Greenland and Antarctica. Davis and Vinogradova (2017) consider a common 60 years' time window 1955–2014 for the trend analysis. For each tide gauge, they express the observed relative sea level using a model that has a constant linear rate over the entire period, plus an acceleration that is zero prior to 1990.

While they may compute a realistic rate of rising by using a linear fitting of 60 years of data, like everybody else, they overrate the positive acceleration occurred after 1990 in the specific geographical area by using parabolic fittings of only 25 years of oscillations about the linear trend.

They conclude with a post-1990 acceleration of up to 0.3 mm/year^2. This is a huge rate, yet they claim it to be "global" and to represent the effect of ice melting in Greenland and Antarctica since 1990.

It will be shown with the example of Baltimore, MD and San Francisco, CA, one tide gauge of the east and one tide gauge of the West Coast of the USA, that the short time window is misleading, and by applying the same short-term logic that Davis and Vinogradova (2017) uses for the East Coast, this could return diametrically opposite conclusion along the West Coast.

2.1 Global Data Sets

As discussed in Parker and Ollier (2017) and Parker (2017), different data sets have been analysed to determine the sea-level rate of rise and acceleration of different data sets:

- The 301 stations of the PSMSL database having a range of years greater or equal to 60 years "PSMSL-301".
- Mitrovica's 23 gold standard tide stations with minimal vertical land motion suggested by Douglas, "Mitrovica-23".
- Holgate's nine excellent tide gauge records of sea-level measurements, "Holgate-9".

- The 199 stations of the NOAA database (global and the USA) having a range of years greater or equal to 60 years, “NOAA-199”.
- The 71 stations of the NOAA data base, USA, having range of years greater or equal to 60 years.
- The eight tide gauges of California of years range larger than 60 years, “California-8”.

All consistently show a small sea-level rate of rise and a negligible acceleration.

The average trends and accelerations for these data sets are as follows:

- $+ 0.86 \pm 0.49$ mm/year and $+ 0.0120 \pm 0.0460$ mm/year^2 for the “PSMSL-301” data set.
- $+ 1.61 \pm 0.21$ mm/year and $+ 0.0020 \pm 0.0173$ mm/year^2 for the “Mitrovica-23” data set.
- $+ 1.77 \pm 0.17$ mm/year and $+ 0.0029 \pm 0.0118$ mm/year^2 for the “Holgate-9” data set.
- $+ 1.00 \pm 0.46$ mm/year and $+ 0.0052 \pm 0.0414$ mm/year^2 for the “NOAA-199” data set.
- $+ 2.12 \pm 0.55$ mm/year and $- 0.0077 \pm 0.0488$ mm/year^2 for the “US 71” data set.
- $+ 1.19 \pm 0.29$ mm/year and $+ 0.0014 \pm 0.0266$ mm/year^2 for the “California-8” data set.

As the largest data sets also include records of poor quality, and 60 years of data are not enough to compute realistic accelerations, quality checks and more restrictive constraints on the time window were introduced to improve the quality of these estimations. By introducing as a quality check the requirement of small differences in between the independent trend analyses by http://tidesandcurrents.noaa.gov/sltrends and http://www.sealevel.info, and by requesting a range of at least 80 years rather than the 60 years, the reliability of the analysis was further improved.

The average trend and acceleration for the PSMSL and NOAA reduced data sets were the following:

- $+ 0.40 \pm 0.27$ mm/year and $+ 0.0090 \pm 0.0208$ mm/year^2 for the “NOAA-120” data set.
- $+ 1.63 \pm 0.23$ mm/year and $+ 0.0021 \pm 0.0192$ mm/year^2 for the “US 39” data set.
- $+ 0.49 \pm 0.34$ mm/year and $+ 0.0063 \pm 0.0263$ mm/year^2 for the “PSMSL-162” data set.

The global sea-level acceleration is therefore in the order of $+ 0.002 \div 0.003$ mm/year^2, i.e. $+ 2 \div 3$ µm/year^2, well below the accuracy of the estimation. This means that the sea levels may rise in the twenty-first century only a few centimetres more than what they rose during the twentieth century. This is by no means alarming.

Fig. 1 MSL in Baltimore, MD (**a**, **b**, **c**), and San Francisco, CA (**d**, **e**, **f**). Data from http://www.psmsl.org visited July 4, 2017. The time window is 1902–1990 (**a**), 1902–2016 (**b**) and 1955–2014 (**c**) in Baltimore and it is 1897–1990 (**d**), 1897–2016 (**e**) and 1955–2014 (**f**) in San Francisco. MSL in Baltimore, MD (**a**, **b**, **c**), and San Francisco, CA (**d**, **e**, **f**). Data from http://www.psmsl.org visited July 4, 2017. The time window is 1902–1990 (**a**), 1902–2016 (**b**) and 1955–2014 (**c**) in Baltimore and it is 1897–1990 (**d**), 1897–2016 (**e**) and 1955–2014 (**f**) in San Francisco

2.2 Baltimore vs. San Francisco, Atlantic vs. Pacific Coasts of the USA

As an example of the variation of sea-level oscillations with the location of the tide gauge, we shall compare the records of the east and West Coasts of the USA using Baltimore and San Francisco as examples. Trend and acceleration analyses with different time windows are provided in http://www.sealevel.info for all the 1269 tide gauge records of variable length and quality of the PSMSL and NOAA databases including Baltimore and San Francisco.

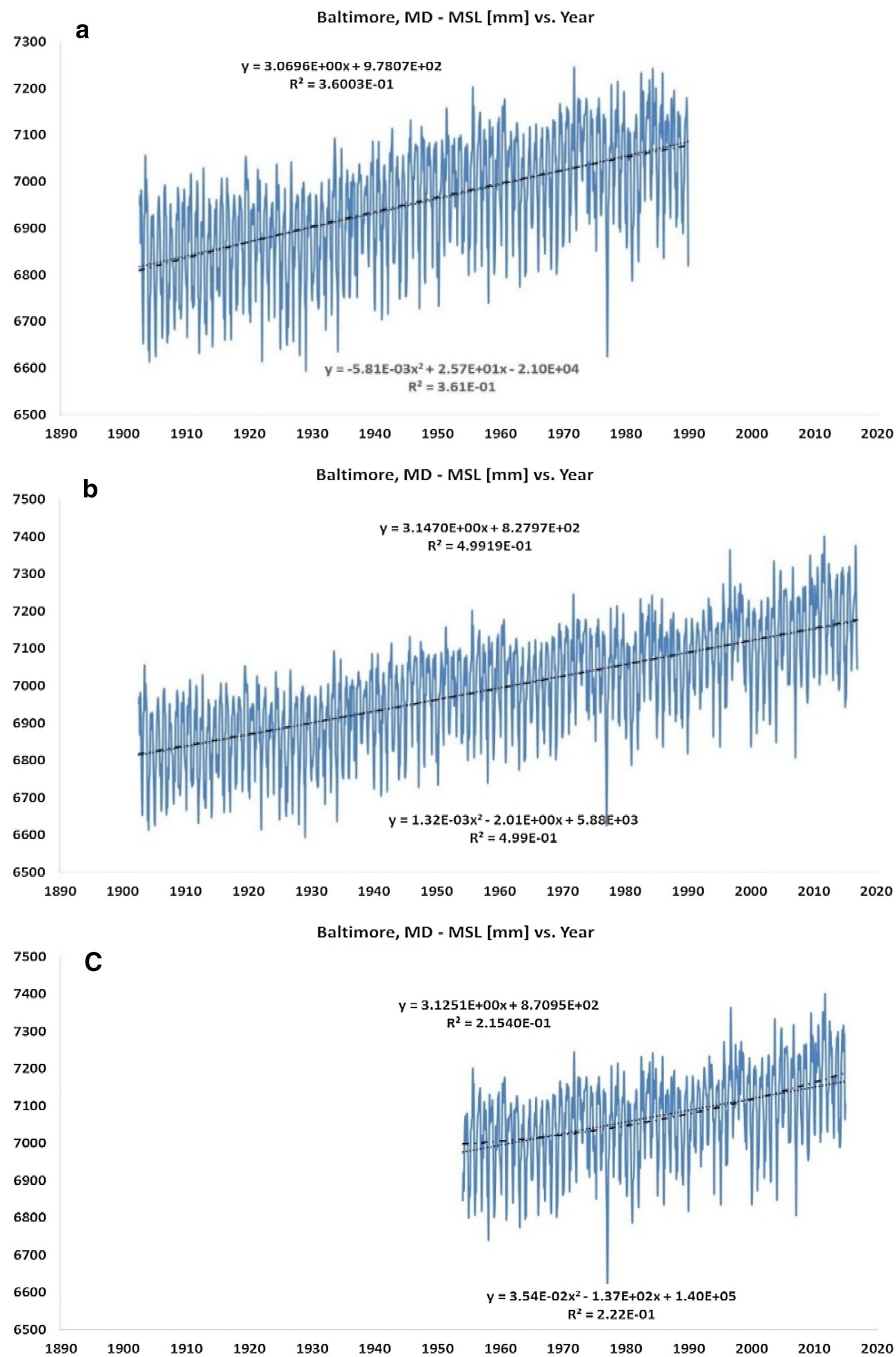
In Baltimore:

- Between 1902/6 and 2016/11, the trend is 3.142 ± 0.129 mm/year, and the acceleration is 0.00302 ± 0.00874 mm/year^2. We take this number as the most likely estimate of trend and acceleration since the start of the twentieth century.
- Between 1955/1 and 2014/12, the trend is 3.100 ± 0.364 mm/year, and the acceleration is 0.0799 ± 0.0463 mm/year^2.

With a 60 years’ short time window, the acceleration is significantly overrated in Baltimore.

In San Francisco,

- Between 1854/7 and 2016/11, the trend is 1.451 ± 0.135 mm/year, and the acceleration is 0.01366 ± 0.00630 mm/year^2.
- As in 1897, there was a datum shift, what is under discussion now is not the different sea-level rate of rise in the nineteenth and twentieth century, but only the acceleration over the twentieth century and the first part of the twenty-first century, between 1897/1 and 2016/11, the slope is 1.936 ± 0.180 mm/year and the acceleration is $- 0.000067 \pm 0.011633$ mm/year^2.
- Between 1900/1 and 2016/11, the trend is 1.919 ± 0.186 mm/year, and the acceleration is 0.001414 ± 0.012313 mm/year^2. We take this number as the most likely estimate of trend and acceleration since the start of the twentieth century.


a
Baltimore, MD - MSL [mm] vs. Year
y = 3.0696E+00x + 9.7807E+02
R² = 3.6003E-01
y = -5.81E-03x² + 2.57E+01x - 2.10E+04
R² = 3.61E-01
7300
7200
7100
7000
6900
6800
6700
6600
6500
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
b
Baltimore, MD - MSL [mm] vs. Year
y = 3.1470E+00x + 8.2797E+02
R² = 4.9919E-01
y = 1.32E-03x² - 2.01E+00x + 5.88E+03
R² = 4.99E-01
7500
7400
7300
7200
7100
7000
6900
6800
6700
6600
6500
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
C
Baltimore, MD - MSL [mm] vs. Year
y = 3.1251E+00x + 8.7095E+02
R² = 2.1540E-01
y = 3.54E-02x² - 1.37E+02x + 1.40E+05
R² = 2.22E-01
7500
7400
7300
7200
7100
7000
6900
6800
6700
6600
6500
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020

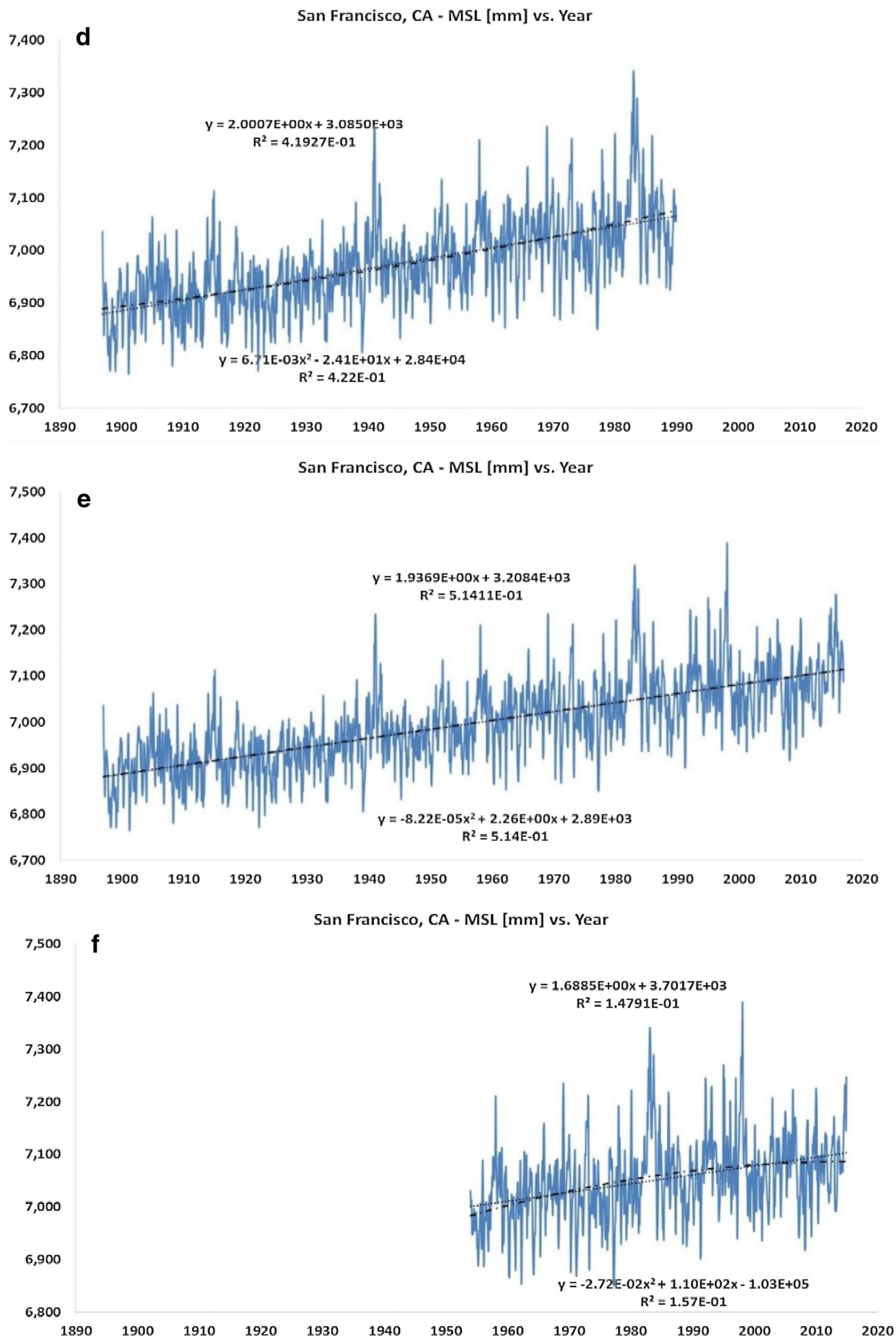


Fig. 1 continued

Fig. 2 Sample sea-level trends and accelerations computed with different time windows from the MSL of Baltimore, MD (**a**, **b**), and San Francisco, CA (**c**, **d**). Data from http://www.psmsl.org visited July 4, 2017. The end of the time window is the time of the last monthly average mean sea-level (MSL) data recorded (November 2016). The start of the time window is this time minus the shown record length

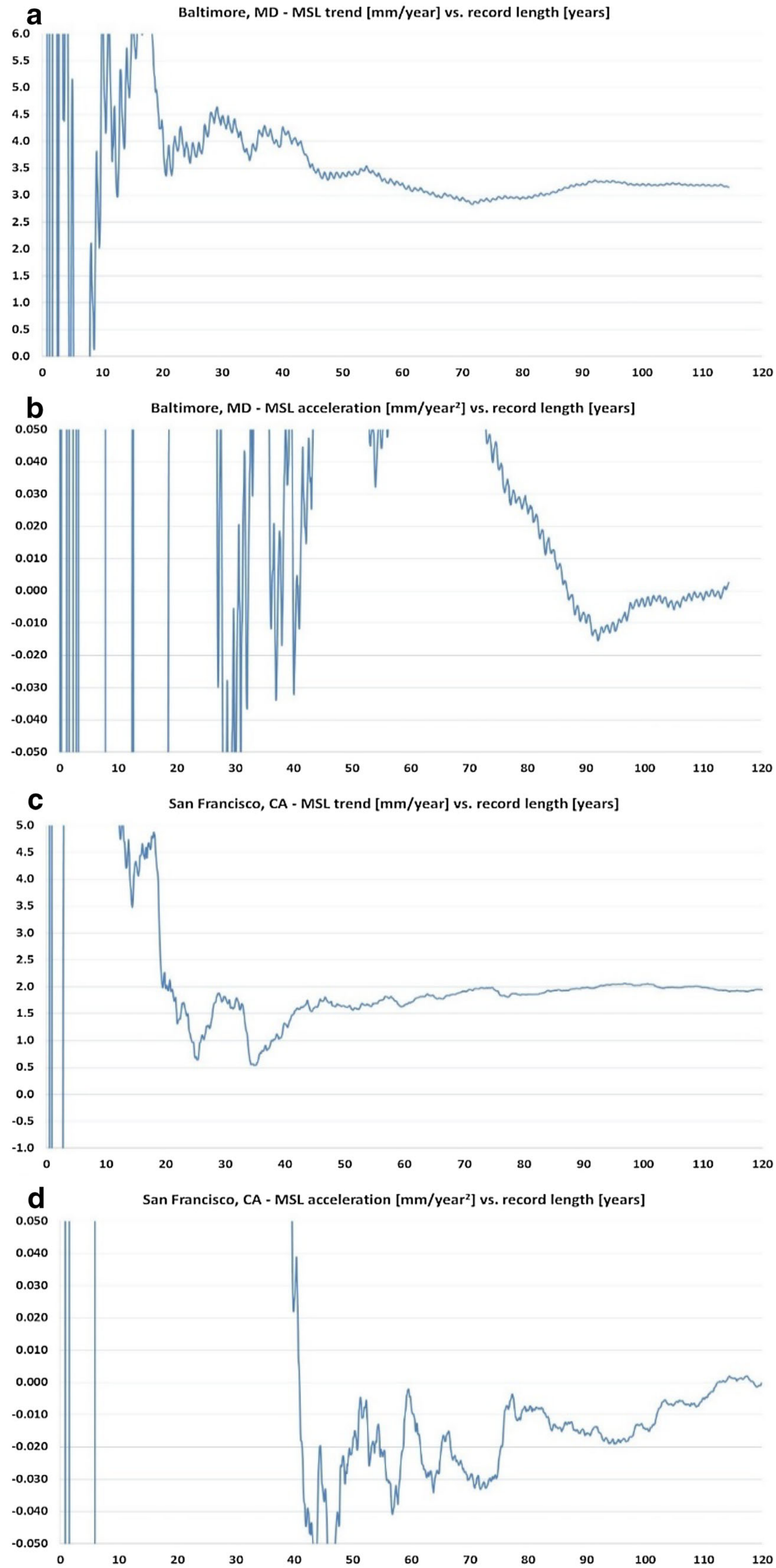


Table 1 Trends and accelerations in the tide gauges of the USA with more than 80 years of data satisfying a first quality check (from Parker 2017) along the West Coast and Alaska (top) and along the East Coast and the Gulf of Mexico (bottom)

	Start	End	Range	Trend	± 95% CI	Accel	± 95% CI
West Coast of the USA and Alaska							
San Francisco, CA, USA	1854.54	2016.87	162.41	1.45	0.14	0.0137	0.0063
Seattle, WA, USA	1899.04	2016.87	117.91	2.03	0.15	0.0085	0.0101
San Diego, CA, USA	1906.04	2016.87	110.91	2.14	0.19	0.0066	0.0131
Ketchikan, AK, USA	1919.04	2016.87	97.91	− 0.30	0.23	− 0.0165	0.0181
Los Angeles, CA, USA	1923.96	2016.87	92.99	0.97	0.24	0.0166	0.0199
Sitka, AK, USA	1924.37	2016.87	92.58	− 2.27	0.28	− 0.0114	0.0234
La Jolla, CA, USA	1924.87	2016.87	92.08	2.16	0.27	0.0134	0.0224
Astoria, OR, USA	1925.12	2016.87	91.83	− 0.19	0.34	0.0104	0.0283
Santa Monica, CA, USA	1933.04	2016.87	83.91	1.50	0.34	− 0.0103	0.0332
Crescent City, CA, USA	1933.04	2016.87	83.91	− 0.80	0.31	− 0.0108	0.0278
Friday Harbor, WA, USA	1934.04	2016.87	82.91	1.17	0.28	0.0072	0.0264
Unalaska, AK, USA	1934.04	2016.79	82.83	− 4.17	0.39	− 0.0187	0.0353
Neah Bay, WA, USA	1934.62	2016.79	82.25	− 1.71	0.30	− 0.0197	0.0286
Juneau, AK, USA	1936.04	2016.87	80.91	− 13.10	0.35	− 0.0329	0.0333
	Averages			− 0.79	0.27	− 0.0031	0.0233
East Coast of the USA and Gulf of Mexico							
The Battery, NY, USA	1856.04	2016.87	160.91	2.84	0.09	0.0086	0.0040
Fernandina Beach, FL, USA	1897.46	2016.87	119.49	2.10	0.18	0.0159	0.0114
Baltimore, MD, USA	1902.46	2016.87	114.49	3.14	0.13	0.0030	0.0087
Galveston Pier 21, TX, USA	1908.37	2016.87	108.58	6.42	0.24	0.0087	0.0173
Atlantic City, NJ, USA	1911.71	2016.87	105.24	4.08	0.16	0.0125	0.0116
Portland, ME, USA	1912.04	2016.87	104.91	1.86	0.15	− 0.0081	0.0111
Key West, FL, USA	1913.04	2016.79	103.83	2.39	0.15	0.0117	0.0110
Cedar Key, FL, USA	1914.29	2016.87	102.66	2.02	0.18	0.0075	0.0124
Lewes, DE, USA	1919.12	2016.87	97.83	3.42	0.24	0.0195	0.0170
Boston, MA, USA	1921.04	2016.87	95.91	2.80	0.16	− 0.0044	0.0130
Charleston, SC, USA	1921.79	2016.87	95.16	3.25	0.22	− 0.0063	0.0176
Pensacola, FL, USA	1923.37	2016.87	93.58	2.30	0.23	0.0052	0.0192
Washington, DC, USA	1924.96	2016.71	91.83	3.22	0.29	− 0.0012	0.0246
Sewells Point, VA, USA	1927.62	2016.87	89.33	4.61	0.23	0.0179	0.0199
Mayport, FL, USA	1928.37	2016.87	88.58	2.58	0.27	0.0152	0.0231
Annapolis, MD, USA	1928.71	2016.87	88.24	3.54	0.20	− 0.0067	0.0180
Eastport, ME, USA	1929.79	2016.87	87.16	2.12	0.18	− 0.0200	0.0160
Newport, RI, USA	1930.79	2016.87	86.16	2.73	0.16	0.0094	0.0148
Kings Pt/Willets Pt, NY, USA	1931.62	2016.87	85.33	2.50	0.21	0.0007	0.0188
Woods Hole, MA, USA	1932.62	2016.87	84.33	2.83	0.18	0.0146	0.0167
Sandy Hook, NJ, USA	1932.87	2016.87	84.08	4.06	0.21	0.0057	0.0195
Fort Pulaski, GA, USA	1935.04	2016.87	81.91	3.20	0.28	0.0272	0.0264
Wilmington, NC, USA	1935.37	2016.87	81.58	2.26	0.35	0.0282	0.0334
	Averages			3.06	0.20	0.0072	0.0168

- Between 1955/1 and 2014/12, the trend is 1.639 ± 0.601 mm/year, and the acceleration is -0.0523 ± 0.0772 mm/year^2.

With a 60 years' short time window, the acceleration is significantly underrated in San Francisco.

Figure 1 presents the trend and acceleration analyses with linear and parabolic fittings of the MSL measured at the two sites by using the simple linear and parabolic fittings of excel. The sea levels are clearly oscillating about a nearly perfect linear trend since the start of the twentieth century. But the oscillations are not all in phase, and mostly upward oscillations along the Atlantic Coast of the USA are coupled to mostly downward oscillations along the Pacific Coast of the USA and vice versa.

To understand the sea-level variations since 1990, it is enough to compare the results of the “classic” trend and acceleration analyses with data up to 1990 and up to present.

With MSL data up to 1990, the trend in Baltimore, MD was smaller, + 3.0696 mm/year compared to the latest trend of + 3.1470 mm/year. The acceleration was also smaller, a negative − 0.01162 mm/year^2 compared to the latest positive + 0.00264 mm/year^2. There has therefore been a positive acceleration in Baltimore, but nothing dramatic.

In contrast, in San Francisco with data up to 1990, the trend was larger, + 2.0007 mm/year compared to the latest trend of + 1.9369 mm/year. The acceleration was also larger, a positive + 0.01342 mm/year^2 compared to the latest negative − 0.0001644 mm/year^2. There has therefore been a negative acceleration (deceleration) in San Francisco, but again, nothing dramatic.

To further support the conclusion of oscillatory patterns only shifted in phase, Fig. 2 presents the sample sea-level trends and accelerations computed with different time windows in Baltimore and San Francisco by using the LINEST function in excel. This figure clarifies the role of the record length in inferring a proper trend and a realistic acceleration. The end of the time window is the time of the last monthly average mean sea-level (MSL) data recorded (November 2016). The start of the time window is this time minus the shown record length.

In both cases, only when the record length is above 90 years is the sea-level trend computed with accuracy. The sea-level trend changes dramatically if the length of the record is less than 90 years long. Records even longer than 90 years are needed to clear up the acceleration of the multi-decadal oscillations, with zero acceleration achieved only with records approaching 120 years of data. With more than 90 years of data, the acceleration is negative in both Baltimore and San Francisco.

To compute positive accelerations up to 0.3 mm/year^2, Davis and Vinogradova (2017) ignore the 60 years’ time window 1955–2014, which is already too short to infer an acceleration trend by parabolic fitting. They use the 60 years’ time window to compute the linear trend, but then they use only the oscillations about this linear trend occurred since 1990. This means they only use 25 years of data to compute the acceleration. Figures 1 and 2 demonstrate that the use of this time window is mistaken.

Table 1 presents the trends and accelerations in the tide gauges of the USA with more than 80 years of data satisfying a first quality check as described in Parker (2017) that are along the Pacific Coast of the USA (West Coast and Alaska) and along the Atlantic Coast of the USA (East Coast and the Gulf of Mexico). In the first geographical area, the average trend is − 0.79 ± 0.27 mm/year and the average acceleration is − 0.0031 ± 0.0233 mm/year^2. In the second geographical area, the average trend is + 3.06 ± 0.20 mm/year and the average acceleration is 0.0072 ± 0.0168 mm/year^2. With proper time windows, there is no significant sea-level acceleration along either the East Coast or the West Coast of the USA.

3 Discussion and Conclusions

It is of paramount importance to discuss the proper way to assess the present acceleration of sea levels. This can’t be done by focusing on the short-term upward oscillations in selected locations. Due to the oscillatory pattern of the sea levels and the contribution to the tide gauge signal of land and sea movements that strongly vary in time and space, it is very difficult to infer any proper trend by using short-term tide gauge results only. Barely in the areas where there are both short- and long-term tide gauges, and their signals are well correlated, the additional information from the longer-term tide gauges may be used to infer proper trends also in the short-term tide gauges, for example by fitting the short-term monthly average mean sea levels depurated of the multiple sinusoidal oscillations of periodicities estimated from the periodicities of the nearby long-term tide gauges. It is clear from the analyses of the “NOAA-120”, “US 39”, “PSMSL-162”, “Mitrovica-23”, “Holgate-9” and “California-8” data set, that the sea level has been oscillating about the same almost perfectly linear trend line all over the twentieth century and the first 17 years of this century.

Davis and Vinogradova (2017) overrate the positive acceleration which they claim occurred after 1990 in one location by using a parabolic fitting of only 25 years of positive monthly average mean sea-level oscillations about the 60 years’ linear trend. They claim there was an acceleration of up to 0.3 mm/year^2 after 1990. That is two orders of magnitude larger than the legitimate values. It is nothing but deceptive to infer global acceleration trends from short records while ignoring additional information from same tide gauges or tide gauges in other locations.

In their analysis and implications for future sea-level rise, then they compare their allegedly observed sea-level accelerations to computed ice mass loss and ocean dynamic contributions to sea-level rise. They conclude that the North American East Coast has recently experienced sea-level acceleration due to the combined Antarctica and Greenland ice mass losses of 0.04–0.15 mm/year^2 depending on the location. We do not support this subjective statement, as there are no significant sea-level accelerations in this area and elsewhere once the effects of the natural oscillations have been cleared out.

The information from the tide gauges of the USA does not support any claim of rapidly changing ice mass in Greenland and Antarctica. The data only suggests the sea levels have been oscillating about the same trend line during the last century and this century.

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